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# TEA QUARTERLY

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# TEA RESEARCH INSTITUTE

OF CEYLON.

Edited by

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THE TEA RESEARCH INSTITUTE
St. Coombs, Talawakelle.

H. W. CAVE & CO. LTD. COLOMBO

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## NOTE.

The Laboratories of the Institute are situated at St. Coombs Estate, Talawakelle, and letters and enquiries should be addressed to the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle. Telegraphic Address :—Research, Talawakelle ; Telephone, Talawakelle 44 (Private Exchange). It is particularly requested that letters should not be addressed to officers by name.

# EDITORIAL

## BLISTER BLIGHT

The subject of Blister Blight for obvious reasons occupies a considerable amount of space in the present number, in which will be found reprinted for general information lectures given to various associations and other notes and interim reports, which it is hoped, will give a general picture of the Blister Blight position at the time of writing and of the various measures which have been suggested for dealing with this disease.

Ceylon was fortunate in that the arrival of Blister Blight occurred only a short time before the dry weather of January-March checked the disease. In contrast, tea in South India became infected some months earlier and considerable areas recovering from pruning suffered badly. It is to be hoped that Ceylon will not lose this advantage as a result of continued pruning for "wet-weather recovery."

The Institute, it is believed, has put the position fairly before those concerned. Whether the risks from Blister Blight are accepted in preference to the suggested changes in regard to time and type of pruning is, of course, a matter for the management of individual estates to decide. Attention may be drawn to the fact that proposed modifications in agricultural procedure between pruning and tipping owe their undoubted value to their effect in assisting the bush to full *potential* yield. They cannot by the nature of things confer immunity or resistance on the bush for the rest of the cycle. To express surprise that a cut-across field, once again in plucking, suffers from Blister Blight is to indicate that the whole point of the procedure has been missed.

Some misapprehension has occurred over the occurrence of 'red' or 'scarlet' blisters. These do not indicate any more 'virulent' race of the fungus, and have been observed ever since the disease occurred in Ceylon. Coloured blisters are formed only on certain types of bushes, many of which give coloured reactions to wounds by sucking insects, etc.

*Attention is drawn to the damage that may result from the use of sprays in greater concentration than that advised, and from their wasteful application in quantities sufficient to cause 'run-off' or 'drip' onto the soil of nurseries. Such practices may cause respectively the death of seedlings or copper poisoning of the nursery soil.*

## FERTILISER RATIONING

*Tea.*—Estates will now probably receive *both* the third and fourth quarter manure quotas. Delivery of third quarter manure is, however, not likely to commence until late in August.

*Old Rubber.*—Delivery of the deferred first quarter manure will commence in July. The question of subsequent deliveries will be reconsidered when further information is available concerning the general policy likely to be adopted in regard to the manuring of old rubber areas, particularly areas which may be cut out in the next five to ten years.

*Young Rubber.*—Normal deliveries of manure will continue.

## ADDITIONAL ISSUES OF PHOSPHORIC ACID AND POTASH

As increasing amounts of the above are becoming available, the Organiser, Fertiliser Rationing, is prepared to issue additional permits, outside the normal quota, to Agents or Superintendents of tea estates who may require extra phosphoric acid and potash. Such additional permits will be for limited quantities only and the particular purpose for which the manure is required must be stated in all applications.

# THE CONTROL OF BLISTER BLIGHT OF TEA*

*(Exobasidium vexans,* Massee)

F. R. TUBBS

## I. INTRODUCTION

Perhaps the title of my lecture today may appear rather audacious but, in my opinion, it is not, provided control is interpreted as the limitation of the damage inflicted to the extent that economic factors allow. I think the time has come to summarise our present views upon the control of this disease, whose possible menace to the Island's revenues as a whole requires no emphasis, and to stress once more that we neither know of, nor expect to find, any *single* master cure. Limitation of the damage inflicted by the disease will only be achieved by the combination of many measures, appropriately varied according to the district, estate, season, and condition of the tea. It is fundamental to my approach today that I hold out hope, not of eradication or cure, but of control.

The use of a single method of control is attractive by virtue of its simplicity, and it is therefore desirable to illustrate the weaknesses inherent in such a narrow approach to the problem. Humid conditions, as you all know, favour the occurrence of this disease. Thus field observation shows that during what we may call the "North East" conditions of sunny mornings, showery afternoons and clear, cold nights the disease persists mainly in four types of locality when it is considerably reduced elsewhere. These are : in hollows where cool saturated air lies at night, over areas of damp soil where moisture arising at night from the warm earth condenses on the under-surface of the colder leaves, in the lee of jungle areas from which cool, wet air currents tend to flow, and under heavy shade where the effects of a passing shower are greatly prolonged. Where, however, widespread mist or humid conditions prevail as in the South West Monsoon, infection occurs over much larger areas, often on hill tops, and apparently quite independent of shade, hollows, jungle, or damp soil.

From the practical point of view, shade reduction markedly reduces blister blight when sunny conditions prevail, but it will be obvious from the foregoing that it only requires a period of misty weather to cast a superficial doubt on the value of the measure. But control measures must be based on the average, just as you prune the whole of a field at one time ignoring the fact that a few bushes have 'run-out' long before. Shade control provides a good example of a measure to whose undoubted general usefulness frequent apparent "exceptions" following upon the intrusion of other factors of temporarily greater importance are to be expected. A "single method" approach to the problem of the control of blister blight provides no protection against such "exceptions" which can only be met by a combination of several measures.

## II. THE DISEASE

To appreciate the lines along which the field control of blister blight must be developed, the life-history of the fungal organism responsible for the disease requires study. The disease is spread by airborne spores, so

* Text used as the basis of a lecture delivered to the Low-Country Products Association, Colombo, on 17th July, 1947, and of lectures to numerous District Planters' Associations.

numerous that the factors limiting its increase are normally those of host and environment, *not* the number of potentially infective spores. This is shown by the occurrence of sudden, locally circumscribed outbreaks at times when the disease is generally at a minimum, by the absence of any observable 'zoning' of infections around highly infected bushes and by the ineffectiveness of local control measures in reducing potential local infection. These spores germinate under conditions of very high humidity, or in very thin films of water. Whether or not an infection follows germination depends upon whether the spore has chanced to alight upon a tea bush, how "resistant" is the individual bush concerned, whether the portion of the host on which the spore rests is *young* and thereby susceptible, and, equally important, whether external factors such as temperature, humidity, light, etc., remain favourable long enough for entry into the host to be achieved. Once entry has occurred, probably in under twenty-four hours in some cases the fungus is safe from weather and from all artificial attack save that of the plucker, until the blister is formed about 3 weeks later. Where the youngest host tissues are attacked, however, the fungus may be defeated by their hypersensitivity, blister formation being prevented by the incontinent death of the host tissues. In older, but still susceptible organs the host tissues achieve sufficient resistance to the invasion of the fungal hyphae to strictly localise the area affected.

From the foregoing it follows that partial control of the disease, in theory, can be achieved by prior protection of the young susceptible tissues, by reducing periods favourable to the disease to less than 24 hours (shade reduction) and by growing ones of greater inherent resistance.

Before further examining these lines of control, we must take into account the type of damage done to the tea bush, and the periods when damage is greatest. The damage is greatest when young buds or stems are affected, death of the whole shoot, or that part of it above the point of infection, following. The consequences may amount, in bad cases, to almost complete loss of crop for weeks, or to a delay in the recovery of pruned fields of many months. Leaf infections cause less damage, since it is only a portion of the assimilating surface that is affected. Since the greatest proportion of infectable tissues occurs in fields recovering from pruning, and since damage at this stage can postpone or reduce yield for many months subsequently, it follows that our interests are most vulnerable in the pre-tipping fields. It is here, therefore, that control measures are especially necessary.

## III. FIELD PROGRAMME

The most important natural controls of the disease in the field are high temperature, dry air, maturity of host tissues and possibly light. Subsidiary factors such as attack on the blisters by insects or by other fungi, and the partial resistance of some bushes do not really affect the general issue at present, though the premature germination of spores before they have left the parent blister may well be of importance under very humid conditions.

The cheapest method of controlling a disease is usually to adapt the details of ordinary agricultural processes to meet it. Since tea is cropped throughout the year, seasonal liability to the disease cannot be avoided. But the field programme can be adapted to allow of the bush passing through its most vulnerable period with the minimum of risk by arranging for "dry weather recovery" to take place over as

large a proportion as possible of the acreage pruned annually.

The second use that can be made of natural characteristics of the disease is to avoid risking the removal of a large part of the immune stems on the bush, merely to await their replacement by susceptible tipping shoots. This involves leaving many more points, and possibly pruning at a higher level than normal. Obviously, such measures are the more desirable the greater the risk of blister blight infection, *e.g.*, whenever wet weather recovery is risked. In such cases, the advantages resulting from cutting-across deserve serious consideration as a matter of interim policy.

A cut-across at the normal pruning level results in rapid recovery and earlier tipping, while a cut-across immediately above the previous tipping level allows of the immediate reformation of the plucking table, provided soft banji is dealt with by early plucking and short rounds. That the mass of young leaves so produced may suffer a heavy infection is no argument against the method, since the same would occur were so many "third leaves" available for blister development on a bush previously pruned in any other way. It may also be noted that the speedier recovery from pruning that results from light pruning can also be used to increase the acreage recovering during dry weather.

A further point concerning methods of pruning to be adopted is that lung pruning should be adopted on estates below 3,000 feet. Above 1,500 feet, some competition between lung growth and tipping growth may occur if lungs are left unplucked. In such cases about half the lungs may be cut back to form a leafy fringe at an intermediate stage of recovery. The lungs should be cut back to the tipping level or above, leaving as much 'spread' as possible, only after the bases of the tipping shoots have safely matured to a point where they are no longer susceptible. Lung pruning is normally unnecessary above 3,000 feet, even as a precaution against repeated attacks of blister blight, fringe pruning to maintain the spread being sufficient.

The early formation of a canopy of new leaves upon the pruned bush may also be encouraged by *early* tipping — in fact, by plucking as shoots arrive at the tipping level. The further advantages of this process are that backward shoots are encouraged to grow more quickly, and that secondaries at all stages of growth are found later, so that some, at least, are less vulnerable when a subsequent attack occurs. Early tipping and light pruning both result in increased yield in the pruning year, and thus may compensate, entirely or in part, for losses from blister blight, which are normally greatest also in the first year after pruning.

These points were more fully discussed in my lecture to the Nuwara Eliya Planters' Association, to which some of you may care to refer, but I would like to add this important point. Neither method of pruning, time of pruning, nor method or time of tipping can be expected to protect new growth on the bush for the rest of the year. The value of these measures, direct and indirect, lies in helping to ensure the speedy return of the bush to full *potential* yield. What happens afterwards is on the lap of the gods, but at least it cannot be as serious as the loss of all tipping shoots, on successive occasions, over large acreages. Of course, protection is never absolute, for if a long wet period were to occur in the middle of a normally "dry period," damage in recovering fields would be almost certain. But this cannot be said to destroy the value of dry weather recovery in an average year;

it only marks our lack of control over the elements.

The only agricultural protection that can be given to fields in plucking is to control the density of shade, especially when periods of sunlight are expected, and to pluck closely during periods of attack, reverting to normal plucking when feasible. There is very little point in leaving the "third leaves" during *bad* attacks, no matter what one's views on plucking are under normal circumstances.

The alteration of agricultural programmes to conform with the foregoing principles may involve direct or indirect loss ; therefore the estimated cost must be balanced against the expected loss from blister blight under the particular circumstances of individual estates and fields. If you decide to accept the latter loss, then it must be remembered later that it was accepted as a business proposition, on which you did, or did not, lose more than expected. The Institute has made it abundantly clear that it considers that the risks arising from blister blight in fields recovering from pruning at elevations above 1,500 feet fully justify the strictest precautions until sufficient experience has been gained to allow of a decision as to whether the risks in a particular estate or district are sufficiently small to justify relaxation.

Reference may be made in passing to the blister blight records now widely kept by estates with a view to facilitating the adjustment of estate programmes. Since the record is intended as a guide to the future treatment of the whole field or area referred to, it is of course essential that the category recorded should be the average of the field or area as a whole, and not refer merely to the condition of a small badly affected area within it. The importance of these records has been stressed by the Chairman of the Board of the Tea Research Institute in his letter of 18th June. I would only add here that everything we have learnt about the fungus, either from laboratory investigation, field experimentation, or estate experience, points to blister blight only being capable of serious damage when a very delicate balance of environment and host factors occurs. Since many of these factors are not within our control, it is of great importance to accumulate such careful records of field-to-field experience as will allow of the correct local use of those we can control, such as time of shade-lopping, time and type of pruning, earliness of tipping, length of pruning cycle, etc.

## IV. SPRAYING AND DUSTING

You will remember an earlier reference to the shortness of the period during which the fungus is vulnerable, *i.e.*, the period between spore germination and entry into the host tissues. The means of *artificial* control available to us at present are based upon harming the fungus before it enters the host and are thus protective, not curative. The fungicidal compounds available may be applied to the bush either by dusting or spraying. The former is usually a less effective method of application, but is cheaper in labour. The great weakness of both these methods is that each new leaf or portion of stem as it unfolds must be protected before it is infected. To do this would require such frequent treatment that there is, in my opinion, no chance that it will ever be an economic proposition to protect the tea *crop* by such artificial means unless some undreamt-of advance occurs.

But if protection over short periods, such as during recovery from pruning, can have long term effects, it may become economic to adopt measures that would

otherwise be too expensive. It is therefore necessary to consider the cost of obtaining protection and balance it against the advantages anticipated. The cost of spraying varies very greatly with the availability of water, while that of both spraying and dusting is affected by terrain, the size of the bush, whether or not the rows are on the contour, and the keenness of the subordinate supervision.

The following data are only approximate but give a reasonably complete interim picture of the costs involved.

(1) *Protection of plants in young clearings.*

Seedlings 0-12 inches in height, in contour rows, 5,600 plants to the acre.

A. Spraying.—1 cooly per acre ; 1¼ oz. Perenox per acre (per treatment).

B. Dusting.—½ cooly per acre ; 10 lb. per acre (per treatment).

(2) *Protection of young clearings during initial recovery after centring.*

As only the shoots produced on the pruned stems are of especial interest, spraying or dusting or mature leaves, etc., should be avoided. If this is done, the cost should not exceed that of treating young seedlings.

(3) *Protection of young clearings during initial recovery after the first pruning subsequent to centring.*

A. Spraying.—Preliminary figures obtained on a well grown young clearing, in contour rows, 5,600 bushes to the acre.

2 coolies per acre, (*i.e.*, one cooly spraying and one for relief, water carriage, mixing, etc.)—(per treatment).

1 lb. Perenox per acre (*i.e.* forty gallons of spray).—(per treatment).

B. Dusting.—No figures available — probably in neighbourhood of 1 cooly and 15 lb. of dust per treatment.

(4) *Protection of mature tea during initial recovery after pruning.*

A. Spraying.—*4-6 coolies per acre, including water carriage, etc. ; 2 lb. Perenox per acre.—(per treatment).

B. Dusting.—2 coolies per acre ; 20-30 lb. of dust per acre.—(per treatment)

(5) *Protection of shoots on mature tea in bearing and of clonal bushes rested for growth of propagation material.*

Provided only those shoots in the immediate vicinity of the plucking table are treated, the cost is not likely to greatly exceed that in tipping fields, where shoots have to be dealt with in all parts of the bush. Protection of the growing tips (only) of shoots on large bushes rested for the growth of propagation material has required labour and materials at the rate of 2 coolies per acre and 1-1½ lb. of Perenox.

(6) *Protection of Nurseries.*

Young seedlings are infectable at the earliest stages of growth and therefore require early protection. The cost of weekly spraying is almost negligible, particularly if a light, fine spray is applied to both surfaces of immature (susceptible) leaves *only*. Heavy application of fungicides only leads to "run-off," from which copper poisoning of the soil followed by stunted growth of the seedlings may result.

The cost of one copper spray, Perenox, used at the rate of 4 ozs. in 10 gallons is at present Rs. 1-70 per lb. A dust, Perelan I, costs 90 cents per lb., and other dusts and sprays are becoming available at prices yet to be ascertained. The lower cost of fungi-

* I am indebted to Mr. Manning, U.P.A.S.I., S. India for a figure of 4 coolies per acre when large trained gangs are employed

cidal dusts, and the lower labour costs involved in their use are offset by the larger quantities required to obtain efficient protection. The cost of application of both sprays and dusts may, however, be subject to drastic revision if new or more efficient appliances are developed.

The frequency with which spraying is necessary materially affects the cost of obtaining protection. Weekly spraying, based on an average production of one new leaf a week on non-banji shoots, was found to be effective in practice, but comparison of the effects of spraying at longer intervals has not as yet been experimented long enough to justify definite conclusions. About ten sprayings would be required if weekly spraying were to be continued from budbreak to tipping in the case of bearing tea or to ripening of the bases of the young primaries in the case of young tea. This would involve relatively small expenditure per acre in the case of young pruned tea, which could be further reduced by arranging to combine dry weather recovery with a shorter subsequent period of weekly spraying. The cost of protecting young clearings also appears quite small enough to justify prior protection where damage from blister blight is anticipated, since the disease can cause the death of large numbers of young plants in their early stages.

Bearing tea, however, is in an entirely different category. An expenditure on pruned fields of from Rs. 10 to Rs. 15 per acre, repeated on some ten occasions, would appear unjustified under normal circumstances. Take for example, a field first sprayed in July, in one of the 'South West" districts, after having been pruned in April and having had all the tipping growth killed off by blister blight, and postulate the worst case, *i.e.*, that the disease is severe until the end of 1947. If the yield in its first year would normally have been, say, 700 lb. per acre, the yield to be expected from July to the time of dry weather comes in January, 1948 might be taken as, say, 400 lb. Of this, 3 months' yield is already irremedially lost, since a practically fresh recovery has to be made. Therefore, by protecting the new growth from July onwards about 200 lb. per acre might be saved, but if protection was only given for the 3 months up to tipping, some even of this would be lost. The total saving might then be, say, in the neighbourhood of 150 lb. per acre. Assuming a potential nett profit per pound less cost of plucking and manufacture (which is saved while the field is out of production) of 40 cents, about Rs. 60 is the maximum sum that can be profitably expended. This would be insufficient to cover the cost of spraying for three motnhs.

In passing I might mention that dissatisfaction with spraying can result from commencing protection too late, too heavy application, spraying of old tissues as well as young, rainfall during spraying or before the deposit has dried on the young shoots, sprayers giving too coarse a mist, and from insufficiently frequent application. It is also often forgotten that blisters will continue to develop for about three weeks after the commencement of weekly spraying from the infections already latent, but safe within the tissue of the host, at the time of the first spraying.

The compounds I have referred to so far are copper fungicides, as the risk of taint arises if sulphur compounds are used. Sulphinette may be used for nurseries, but sulphur dusting is ineffective in controlling blister blight.

As regards the fungicidal compounds available, I understand that the products of

Imperial Chemical Industries, Messrs. Strawsons (Brown & Co.) and of the Swiss Sandos Firm (Baur & Co.) are either available or expected. The price factor per acre per treatment requires consideration in each case. In this respect it may seem rather astonishing that a country so dependent on revenues from its major industry should still levy import duties of from 15 per cent to 25 per cent upon spraying and dusting apparatus and upon fungicidal compounds for the use of the industry. This is a subject which is more than ripe, I suggest, for official reconsideration.

Before concluding I will refer briefly to our results on another subject — that of the influence of manuring on blister blight. Additional manuring, by raising yield in blister-free periods, may compensate to some degree for losses from this disease. But from an extensive series of records, collected with Dr. Eden's co-operation from the Passara manurial experiments, no indication whatever was obtained that either supply or starvation of phosphate (30 lb. per acre per annum), nitrogen (40 lb.) or potash (20 lb.) for a continuous period of twelve years had led to any resultant immunity' or 'resistance.' It can be said, with reasonable certainty, that whatever effects may or may not be found in future, the data already obtained indicate that it is not in this easy way that salvation from blister blight is to be obtained. In fact, we have to face the fact that vigorous, high yielding tea, by virtue of its greater proportion of young tissues at any one time, is likely to suffer from a higher total of infections, and has in fact been found to do so.

## V. CONCLUSION

To summarise the present position, I would emphasise that so far I have received no information that would suggest that stringent measures are immediately necessary at elevations below 1,500 feet, but until we know whether the disease will be more serious at these elevations later in the South West Monsoon, no generalisation is, of course, possible. Above these elevations the adoption of the following measures are recommended according to the degree of blister damage that is apprehended in the particular circumstances of an estate or division. In this connection it must be emphasised that "upper divisions" above a seasonal mist line will require more radical measures than lower divisions enjoying a sunnier climate.

(a) Concentration of the pruning programme to obtain dry weather recovery from budbreak onwards, for as long a period as feasible.

(b) Light pruning at the end of dry period.

(c) Much lighter pruning when fields are made to recover in seasons favourable to blister blight.

(d) Fringe pruning at elevations above 3,000 feet, merging into lung pruning at lower elevations.

(e) Careful choice of those fields, if any, that are still pruned for wet weather recovery as regards aspect, lie of land, and permanent shade.

(f) Early tipping of all pruned fields as they recover, but not at a lower height above the pruning level than normal. Side branches (fringe) or lungs should not be shortened at low elevations until there is a good canopy of new leaf on the bush, and even then not below the tipping level.

(g) *Short* rounds, with closer plucking when blister is frequent.

(h) More frequent lopping of medium shade to take full advantage of all dry periods, thinning of high shade where necessary, and increased use of green manures with a view to avoiding any reduction in the amount of green stuff available for incorporation at forking time.

(i) Regular spraying, prior to and during weather favourable to the disease, of nurseries and of *young* clearings, temporary spraying of young pruned fields if recovering in wet seasons, and possibly of supplies, provided that tests to ascertain costs per acre under local conditions have indicated that it will be worth while.

(j) Avoidance of excessive applications of fungicides, *i.e.*; to old leaves, or in sufficient quantity to lead to "drip," especially in nurseries.

(k) Selection of clones for resistance to blister blight.

There is no one measure that will give complete protection ; only a judicious use of all these measures can be expected to reduce the effect of the disease to the minimum feasible at an economic cost. To this end, facing the unpleasant fact that the minimum may still in some cases be uncomfortably large, the agriculturist must adapt his measures. On our part, our search for new lines of attack on the disease, and for new and cheaper methods of control, will, we can promise, continue to be vigorously pressed forward.

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# AN INTERIM REPORT ON BLISTER BLIGHT SITUATION FOR THE INFORMATION OF AGENCY HOUSES

*(Reprinted for Information)*

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A short *communique* has already been issued to the Press, of which the following is an amplification :—

Since the beginning of the present week a sharp increase in the amount of infection on young growth has occurred on tea situated at elevations of 3,000 feet and above in localities where mist or rain has been experienced to any considerable extent recently. The badly infected areas are often sharply localised in accordance with the mist distribution, but there is in addition a general, though less serious, increase in other areas.

The Institute has advised all estates above 1,500 feet to concentrate as large a proportion as possible of the annual pruning programme into periods which will cause recovery from pruning, between bud-break and tipping, to occur in dry weather. The extent to which such a policy is adopted, in spite of its practical disadvantages, naturally depends upon the extent of the loss from blister blight that is feared.

There has been a general effort to adjust pruning programmes to meet the novel conditions that result from the presence of the blister blight disease. Never-

theless, the sharpness of the recent rise in infestation underlines the very serious potentialities of the disease. The Institute therefore desires once again to draw the attention of those interested, who have not as yet taken steps to avoid wet weather recovery from pruning, to the serious risks that are being run.

Areas of tea are at present to be seen being clean pruned in the up-country wet zone side by side with badly affected first year fields. Unlike fields that have already reached the tipping stage, such areas may suffer from the death of young buds as they develop on the pruned frame. If this occurs, crop will be lost for months, rather than weeks.

At lower elevations, where the monsoon rains are regularly punctuated at intervals of a few days by periods of bright hot sun, the risks may not prove as great as in wetter districts, provided shade is kept in strict control by frequent lopping.

It is therefore recommended that all programmes which still involve wet weather pruning be subjected to repeated review. The advantages of granting a wide local discretion in delaying pruning, or altering the programme of field work at short notice, will be very apparent.

Concentration of the pruning programme demands a far higher number of pruners than normal, and attention is drawn to the possibility of using learners for light pruning where a temporarily lower standard of work might be accepted

The type of pruning to be adopted has been discussed elsewhere (*Tea Quarterly*. Vol. XIX, Part I, May 1947, pages 23-25) but two points require amplification. Firstly, lung pruning is desirable, at least at elevations below 3,000 feet, the lungs being cut back at tipping time at or above the *tipping* level and care being taken that some leaf is left on the pruned lung branch. Secondly, in those cases where some wet weather pruning is *inevitable,* the risks involved could be materially reduced by adopting the policy, as a temporary expedient, of skiffing twice in a cycle. For example, a field which must unavoidably be pruned in July 1947 would be skiffed, on the slope, at a height in the centre of the bush of 1 in. to 1½ ins. above the tipping joint, the cuts being rather above this on the upper side and below it on the lower. The slope is intended to facilitate the *thorough* removal of the numerous soft banjis which are produced for about 3 rounds just after the bush comes into plucking, a process which is essential if yield is to be maintained. Plucking should be close, and commenced immediately leaf appears on the skiffed surface. It is desirable, if possible, to plan in advance for adequate labour to be available to deal promptly with the "banji" rounds. The second skiffing of such a field might be carried out 15 or 21 months later in order to avoid interference with the normal dry weather pruning programme of December-January, 1948-49.

If the estate programme permits, a higher skiff might be given as a temporary measure to extend the cycle. In neither case should small branches below the pruning level be cleaned out.

The importance of choosing fields for such treatment that have an eastern aspect, controllable types of shade, and are not situated in a mist belt, requires no further emphasis.

This note is intended not to create alarm, which is essentially unproductive, but to underline and extend advice already given on the subject of the modification of cultural practices to meet the existing situation.

(Sgd.) F. R. TUBBS.

(Sgd.) Roland V. Norris, Director,
Tea Research Institute of Ceylon, St. Coombs
Talawakelle, 27th June, 1947.

### AFTERNOTES

(1) Copies of this Memorandum were sent to all district and sub-district P.A.'s.

(2) At elevations above 3,000 feet large upright branches left as lungs will, if allowed to grow freely, compete with the growth of the tippings shoots in the centre of the bush. Large lungs are quite unnecessary at high elevations, and the "fringe" branches referred to in the Conference Proceedings are quite sufficient.

(3) Tipping is not, of course, carried out after a cut-across such as that discussed above, the new shoots being plucked to one leaf. If the first pluckings are at all late, banjis will form and crop be lost.

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# A LEAF DISEASE OF TEA NEW TO CEYLON

F. R. TUBBS

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[Text of a lecture delivered to the Pussellawa Planters' Association on 11th November, 1946. Advice subsequently modified is marked with an asterisk. The paper is published to illustrate, by comparison with other articles in this number of the *Tea Quarterly*, the refinement in the application of agricultural control measures that has resulted from experience. Only by continued careful adaptation of the field programme to local conditions will still further progress be made, except in so far as fundamental research may open up hitherto unsuspected lines of attack upon the fungus.]

### INTRODUCTION

With your Chairman's permission, I am taking this opportunity to describe to you a leaf disease of tea that has recently occurred in the Dolosbage and Pussellawa areas and which is new to Ceylon. I wish to emphasise that much of the available information upon the disease is derived from experience in other countries. In other words we are as yet necessarily ignorant of the details of the behaviour to be expected from it under Ceylon conditions.

### NORTH INDIAN BLISTER BLIGHT

Some of you may be acquainted with the so-called "Blister Blight" of tea in North India. This disease has been known on tea since 1858 and, though at times it has caused alarm and consternation, it may be noted that the Assam and Darjeeling tea industries still survive. The causal fungus in North India is *Exobasidium vexans*. Until this year, this disease had not been reported from either South India or Ceylon. In the last fortnight, however, we have received information of its presence in the Annamallai district of S. India, while specimens exhibiting typical symptoms have been received from one estate in the Dolosbage area, and one in the Pussellawa area. It is not, as yet, certain whether the causal fungus is identical with the North Indian species.*

### SYMPTOMS

The symptoms referred to render affected bushes very conspicuous in the

later stages of the disease. The spores are airborne and very small. On germination, penetration of the leaf tissues is affected, and growth proceeds in and between the cells of the leaf. This stage may be detected by the existence of small translucent patches, visible when the leaf is held up to the light.

As growth proceeds, these patches normally develop a concavity on the upper side of the leaf, and a swelling on the lower side, though these positions may be reversed. The swelling is the 'blister' from which the disease obtains its name. The swelling develops and assumes the appearance of a small piece of white or brownish dough affixed to the leaf, from ¼ in. to ½ in. in diameter. Red blisters are sometimes found due to pigment developing as a wound reaction in certain types of bushes. Numerous patches develop on the younger leaves and, less frequently, on the young green stem. In the latter case the whole shoot above the part of infection may blacken and die. Where the attack has been severe, a group of such bushes may present an alarming appearance.

## OCCURRENCE

The disease has so far been reported from two neighbouring districts in Ceylon, and it is not possible to say whether it will spread, remain local, or die out. It appears to affect tipping fields the worst. The two cases in Ceylon have been 1st-year fields and in South India the disease is reported as inflicting the greatest damage in young fields and the least in four-year-old fields. In North India it is reported as being worst in fields recovering from pruning, appearing erratically in a field and not forming a continuous patch spreading from a common origin. It is not continuously severe; if it were, the industry would not have survived. The fungus appears to survive on bushes growing under local favourable conditions, major infection of the tea taking place by wind-blown spores only when humidity and temperature are favourable.

## PLANT RESISTANCE

It is said that jats vary in resistance to the disease. Assam indigenous is generally agreed to be the most susceptible, China, Manipuri and Hybrid being, at least under some conditions, less susceptible. Since we are permanently blessed with the jats our predecessors have left us, it is of more practical interest to note that individual bushes may be found that remain healthy when surrounding bushes are badly affected. If this is true under Ceylon conditions, it provides another pointer to the value of mother bush selection and of the vegetative propagation of resistant types for supplying.

## SOUTH INDIA

Some details of its occurrence as a new pest in South India may be of interest. It was apparently first reported in the Annamallias on the 23rd September and has since been found over a large part of the district.* Climatic conditions there appear to have been similar to those experienced in Ceylon, the South West rains running on rather longer than usual. The damage anticipated is loss of crop, but up to the date of our information (28th October, 1946) serious damage had not apparently occurred. (Note :—Later reports, of course, gave instances of damage inflicted in widely dispersed districts in South India).

## ACTION

It is natural that any new leaf disease in a crop such as tea and especially one confined to young growth, should cause uneasiness. I would, however, suggest a sense of proportion. Every leaf disease of tea appears at sometime or other to have been described as disastrous, but to use such terms before we have any knowledge of how it will behave in Ceylon is merely alarmist, and serves no useful purpose

whatever. It is obvious that two things are required: The collection and examination of information concerning the disease in Ceylon, and the use of such reasonable and practical methods of control as are possible.

A Information

Will you please keep a lookout for plants, tea or other, which exhibit the symptoms I have described and supply the Institute periodically with full details of your observations.*

1. Severity of attack on different jats of approximately the same age from pruning.
2. Resistance of individual bushes.
3. Elevation and aspect of affected fields.
4. Variations in severity with age from pruning.
5. Rates of spread and notes on any observations as to its mode of occurrence in the field.
6. Other plants or weeds affected (Camellias, Eurya, Gordonia, Rhododendron, etc.)
7. Seasonal variations with exact dates of observation of any sudden outbreaks

B. Remedial Measures

The above request presupposes that you will have the opportunity to record such observations. What can you do to avoid multiplying such opportunities? Frankly, as regards protecting your estate as a whole, in advance, nothing. It is quite impractical as a matter of economics to suggest the routine spraying of a perennial leaf crop just as a protection. Again, spraying the outside of the leaf once the fungus is inside the leaf will not eradicate it.

The only recourse is to limit the production of spores, and their spread, by picking of all affected leaves and burning them, on the spot, at once.* The possibility of reducing liability to disease by alteration in cultural practices such as the length of the pruning cycle, by early tipping or by pruning at any particular season of the year may emerge from the data collected, should this disease make any further headway in Ceylon.* But in-so-far as young tipping shoots are liable to especial damage, ensure that there are sufficient leaves on the pruned bush to carry it through any attack during the early stages of recovery from pruning.

# BLISTER BLIGHT

## THE INFLUENCE OF EARLY TIPPING ON YIELD*

C. ALLDAY

Today, with ever increasing costs of production, every extra pound of tea harvested helps towards keeping these costs within economic bounds. One may ask, how can the yield be improved when a shortage of artificial manure and Blister Blight have to be contended with? Would early tipping help towards these problems?

The object of tipping is to stop the growth of the primaries, and thereby induce them to make secondaries which later form the plucking table of the bush. If pruned tea is left untipped until the primaries have become red from the base upwards, it will be observed in a number of jats that very few laterals are produced. Tipping at this

* The Institute does not necessarily endorse the views expressed in papers contributed by persons other than members of the staff.

stage, apart from being expensive, is equivalent to a light prune, wastes a considerable amount of the reserves of the bush in the shape of tippings thrown away, while the time and energy spent by the primaries growing up in an unchecked state could have been utilised in forming the secondaries. In other words, late tipping is a means of restricting crop.

The ideal method of tipping would be to stop the growth of every primary as and when it reached the level at which the work was to be undertaken. As this might, in some cases, possibly be thought uneconomic, it is suggested as a compromise that tipping be undertaken when the *tips* of approximately half the primaries have reached the tipping level on half the bushes. If tipping is undertaken in this manner, all the secondaries do not grow simultaneously and therefore are not all susceptible to an attack from Blister Blight together. The method therefore provides protection against isolated infection periods, but not, of course, against the effects of a long and continuous period of weather favourable to infection. Also the bushes are brought into plucking earlier, which must increase the yield at the beginning of the cycle.

In view of the importance of increasing yields, and of taking precautions to try and decrease possible damage from Blister Blight, the following notes are published in the hope they may prove of interest and help.

The table shows the yields of some fields at varying ages from the commencement of pruning, during the early stages of two pruning cycles, and in all cases it will be seen the yields are higher when the tipping has been carried out earlier. It is not claimed that the whole of the increase in yield can be put down to earlier tipping, for some of it is accounted for by a lighter type of pruning. This also is recommended by the Tea Research Institute as another means of combating the ravages of Blister Blight. The opinion is generally held that leaf which can be harvested during the tipping period is a negligible quantity. While this is so if the majority of the primaries have been allowed to grow up, quite substantial yields may be obtained before the first plucking if the tipping is undertaken early. This is clearly apparent in the table if it is borne in mind that only a small area of any particular field comes into plucking on the first round.

The above fields represent 455 acres, pruning in both cycles having commenced on 1st June and ended by 31st January. Any discrepancies in the times of pruning individual fields can be ascertained by the differences in "Days at 30th April." Final yields are up to 30th April in both cycles, so 334 days shows pruning as having commenced on 1st June. Field "M", 5,000 feet elevation, is of a very poor jat ; it was given a cut-across this cycle at the previous tipping level, and the effect on yield of this light pruning is of interest. During the whole of the previous two-year cycle this field gave a yield of only 855 pounds of made tea per acre.

The figures in the table represent an increase in "This Cycle" of 33,365 lb. made tea or 73 lb. per acre. The importance of earlier tipping as a means of increasing crop during the first year from pruning, thereby alleviating some of the evil effects of Blister Blight on yield in the early part of the cycle, is apparent.

If these notes should persuade any one to try this method, it may be of interest to him to know that the cost of tipping is greatly reduced. Knives are unnecessary except for any fringe lungs, and if the second tipping is correctly timed, *i.e.*, when those primaries untipped at the first tipping

| Field | PREVIOUS CYCLE | | | | | | THIS CYCLE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Days from commencement of pruning to (a) 1st Plucking | (b) April 30th | Yield in pounds per acre from commencement of pruning up to 120 Days | 180 Days | 240 Days | April 30th | Days from commencement of pruning to (a) 1st Plucking | (b) April 30th | Yield in pounds per acre from commencement of pruning up to 120 Days | 180 Days | 240 Days | April 30th |
| A | 212 | 334 | 0 | 0 | 59 | 250 | 141 | 334 | 1 | 48 | 115 | 381 |
| B | 215 | 334 | 0 | 0 | 21 | 190 | 143 | 334 | 3 | 40 | 114 | 402 |
| C* | 145 | 304 | 0 | 27 | 104 | 384 | 129 | 334 | 23 | 139 | 254 | 599 |
| D | 228 | 295 | 0 | 1 | 27 | 161 | 158 | 278 | 2 | 38 | 173 | 234 |
| E | 198 | 273 | 0 | 0 | 34 | 111 | 154 | 224 | 6 | 53 | — | 142 |
| F* | 129 | 261 | 0 | 3 | 102 | 258 | 123 | 273 | 7 | 69 | 232 | 333 |
| G | 262 | 253 | 0 | 0 | 0 | 4 | 190 | 223 | 0 | 36 | — | 81 |
| H | 196 | 164 | 0 | — | — | 0 | 131 | 166 | 4 | — | — | 48 |
| I | 214 | 159 | 0 | — | — | 0 | 167 | 181 | 0 | 49 | — | 55 |
| J* | 159 | 138 | 0 | — | — | 2 | 142 | 162 | 5 | — | — | 54 |
| K* | 175 | 137 | 0 | — | — | 0 | 121 | 138 | 7 | — | — | 37 |
| L | 210 | 136 | 0 | — | — | 0 | 139 | 131 | 10 | — | — | 18 |
| M* | 329 | 99 | 0 | — | — | 0 | 51 | 96 | — | — | — | 179 |

**Note.**—When "Days" at 30th April exceed either 120.180 or 240 days respectively and no crop has been harvested "0" is entered in these columns. similarly when the number of days is less, a "—" is shown. All fields are on a three-year cycle except those marked *; these two-year fields. Any crop harvested during the time of prnning has not been included.

have reached just above the tipping level, approximately 12 days later, the tippers can bring in up to 45 lb. green leaf per head from medium jat fields. Men are at least twice as expensive as women and appear to take no interest in the amount of leaf plucked. As an encouragement, and as a means of saving labour, particularly when tipping has to be carried out in the "rush" months, a proportion of the plucked leaf may be given as over-pounds.

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# BLISTER BLIGHT*

## SOME FINANCIAL ASPECTS OF ITS CONTROL

W. R. VAN DER KISTE

Blister Blight arrived in Ceylon in late 1946 and appears to be determined to remain. South India took drastic measures in an attempt to eradicate it, but Ceylon from the start, and rightly as time has proved, concentrated on control. Now control of a disease or pest requires knowledge, and all concerned in tea planting have been asked to study and notify their discoveries, so that our knowledge of *Exobasidium vexans* increases daily. The following are therefore only the opinions of an individual at the time of writing.

Blister blight would appear to have two natural controls or requirements. First, a quantity of tender young tea shoots, (leaves and stalks), and next, suitable weather. Obviously therefore the methods of attack are on these lines : (1) Deny it the tender shoots that act as hosts and (2) make the weather unfavourable. The first may be possible, but would mean the end, for the time being at any rate, of tea planting in Ceylon ; the second is at present beyond human ability or understanding.

Attack on these lines, the only ones at present evident, cannot be completely successful, but variations would appear to be possible to give partial success. For (1) read "Reduce the number of shoots that are attractive enough to act as hosts to the blight" and for (2) read, "When a large quantity of such hosts must be present, let the weather be at its least favourable for blight."

Brought down to practical planting this means : (1) Get the crop off the bush and into the factory before the blight does much damage, *(i.e.)* short plucking rounds, and (2) let the period between pruning and the end of tipping coincide with the dry weather, *(i.e.)* prune only at certain times of the year.

Now this is where the financial aspect has to be considered. It is all very well to go in for shorter and shorter rounds. Such will in theory tend to give greater crop over the year, but will result in smaller quantities in each basket, and hence increased cost. It is for the practical planter to use his knowledge of the individual estate and what he sees of the incidence of the blight, to obtain the happy mean : as short rounds as are economic.

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* The Institute does not necessarily endorse the views expressed in papers contributed by persons other than members of the staff.

Generally speaking, the more the bush is flushing, the shorter the round can economically be. Thus for short rounds we need primarily (a) food and (b) rapid flow of sap from roots to flushing points. (a) means manure in increased doses and (b) requires clean pruning to give straight clean new wood.

Thus to get our first method of attack we require expenditure on manure and good pruning, and frequent plucking rounds.

The second line of attack, pruning only at certain times of the year, brings in several factors for consideration. Either the area to be pruned must be reduced, or the labour force increased, or more probably both. Reduction of the area means longer pruning cycles, and for this to be economic the requirements are more manure and clean hard pruning. Now these factors have already been found necessary in our first line of attack. The other factor, a larger gang of pruners, is however new. More pruners mean more dependents and non-pruners; a larger labour force means expenditure on housing; it also means that more work that is not directly productive must be given, particularly in the non-pruning months. While this will eventually lead to increased crop, it will immediately put up the cost of production.

Yet another factor to be considered is the effect of harder pruning in slowing up the rate of return to plucking. It can only be carried out early in the pruning season, and the relatively lighter pruning towards the end. The pruning programme has now become more of a headache than ever and must be varied to suit each field of each estate.

To sum up :—

(1) *Exobasidium vexans* can be controlled, but will still cause loss of crop, and the control will increase the cost of production.

(2) The amount of crop lost will be inversely proportional to the increased expenditure, and the economic mean will be different on every estate.

(3) the individual planter will have to find out this economic mean, for no hard and fast rule can be laid down, but the following will determine it :—

(a) Labour force.

(b) Rate of growth of flush, depending on food for the bush and its rapid supply to the flush.

(c) Weather being normal.

(4) 3 (a) Means expenditure on lines and non-productive work.

3 (b) Expenditure on manure and

3 (c) is entirely uncontrollable and unpredictable.

# NOTES ON BLISTER BLIGHT

F. R. TUBBS

The very large amount of visiting and advisory work involved in dealing with the problem of blister blight inevitably draws attention to numerous points requiring further clarification or emphasis. The following subjects are dealt with in note form, any connected account being as yet premature :—

*1. RED BLISTERS.*

The occurrence of red blisters was noted and portrayed by McRae in North India as early as 1910. In Ceylon they have been known since the disease first arrived in the Island. Any suspicion that they represent a more "virulent" type of the fungus can be allayed. The formation of a red blister is dependent upon the characteristics, not of the fungus, but of the particular tea bush. Those bushes having a tendency to the production of pigment, especially as a wound reaction following upon attack on a sucking insect or other injury, form red blisters. The relationship between 'red blister' and particular host plants is illustrated in the St. Coombs clonal plots where all bushes of clones 1005 and 1082 display coloured blisters, while many other clones display no such tendency. The density of coloration varies from clone to clone. The colouring matter is present in the cell fluids of the host, and not in the fungal hyphae. The attacks on clones 1082 and 1005 gave no indication whatever of any greater 'virulence,' it may be noted. Bald's* reference to red blister is erroneous.

*2. ATTACKS IN 'OLD' TEA FIELDS.*

Emphasis on the need for protection from blister blight of fields recovering from pruning has led to the assumption that the flush of 'old' fields is more resistant and thus to fears, when attacks are observed in 'old' fields, that a more virulent type has emerged. It should be noted that the only tissues attacked are young, and that as yet we have no evidence that tissues of the same youth differ in susceptibility, according to whether they have developed on 'old' or on freshly pruned bushes respectively. The presence of blisters on apparently mature leaf results from infection rather late in the development of a young leaf, in wet or cloudly weather. The blister does not appear for some three weeks, by when the leaf appears relatively mature, and may then persist during wet weather for some time on the ageing leaf

*3. RESISTANCE OF INDIVIDUAL BUSHES AND OF CLONES*

Variations in resistance between individual bushes in the field are often very marked and are paralleled by similar differences between different clones. The following data from the clonal plots at St. Coombs are based upon a total of twenty recordings at nine day intervals, *i.e.*, approximately six months. The clones referred to were grown under similar conditions and without shade. They were pruned in May 1946, the records being from 28th January to 15th July, 1947, during which time they were plucked on regular nine day rounds. The relatively low blister counts are due to the effect of the dry weather, absence of shade and regular rounds of fairly close plucking. The marked varietal differences in susceptibility render obvious the value of selection of clones according to their resistance to blister blight.

* C. Bald—Indian Tea, Its Culture and Manufacture, Calcutta, 1940.

| Clones | Mean blisters per bush per 9 days | Mean % bushes infected | Clones | Mean blisters per bush per 9 days | Mean % bushes infected |
|---|---|---|---|---|---|
| 425 | 0·2 | 6·4 | 15 | 1·9 | 31·0 |
| 742 | 0·2 | 5·0 | 896 | 1·9 | 13·3 |
| 20 | 0·3 | 17·5 | 946 | 1·9 | 11·7 |
| 26 | 0·3 | 6·6 | 37 | 2·1 | 63·8 |
| 235 | 0·3 | 7·5 | 34 | 2·2 | 24·3 |
| 170 | 0·4 | 7·4 | 46 | 2·5 | 29·5 |
| 740 | 0·4 | 15·0 | 839 | 2·5 | 30·4 |
| 1128 | 0·5 | 8·3 | 1456 | 2·5 | 7·7 |
| 997 | 0·6 | 8·6 | 18 | 2·6 | 35·0 |
| 33 | 0·7 | 11·7 | 142 | 2·6 | 23·0 |
| 407 | 0·7 | 18·2 | 13 | 2·7 | 32·0 |
| 708 | 0·7 | 7·9 | 777 | 2·7 | 27·7 |
| 1054 | 0·7 | 9·3 | 510 | 2·8 | 40·0 |
| 384 | 0·8 | 13·6 | 862 | 2·8 | 35·0 |
| 397 | 0·8 | 21·8 | 19 | 3·1 | 30·0 |
| 928 | 0·8 | 18·9 | 343 | 3·1 | 45·5 |
| 1000 | 0·8 | 7·8 | 1005 | 3·1 | 40·0 |
| 1016 | 0·8 | 21·9 | 16 | 3·2 | 31·7 |
| 1001 | 0·8 | 13·3 | 293 | 3·2 | 31·3 |
| 1446 | 0·8 | 9·7 | 777 | 3·2 | 39·6 |
| 32 | 1·0 | 15.0 | 934 | 3·3 | 32·0 |
| 128 | 1·0 | 20·0 | 1530 | 3·3 | 30·0 |
| 603 | 1·0 | 15·5 | 331 | 3·5 | 41·3 |
| 1526 | 1·0 | 21·0 | Seedlings | 3·7 | 35·9 |
| 43 | 1·1 | 19·6 | Seedlings | 3·8 | 31·5 |
| 1526 | 1·1 | 20·5 | 23 | 3·8 | 36·7 |
| 105 | 1·2 | 32·5 | 331 | 3·9 | 27·7 |
| 1016 | 1·2 | 21·7 | 45 | 4·2 | 37·8 |
| 1076 | 1·2 | 19·2 | 1530 | 4·2 | 36·0 |
| 1 | 1·3 | 33·6 | 22 | 4·3 | 40·9 |
| 4 | 1·3 | 24·5 | 1118 | 4·4 | 14·0 |
| 396 | 1·4 | 27·0 | 216 | 6·2 | 31·3 |
| 960 | 1·4 | 40·0 | 14 | 6·4 | 38·3 |
| 9 | 1·5 | 25·8 | 1114 | 8·4 | 62·0 |
| 687 | 1·5 | 18·8 | 222 | 8·5 | 31·7 |
| 1387 | 1·5 | 15·8 | 216 | 9·4 | 44·1 |
| 999 | 1·6 | 31·4 | 1082 | 11.3 | 49·5 |
| 21 | 1·7 | 23·8 | Seedlings | 11·6 | 47·2 |
| 43 | 1·7 | 22·5 | 25 | 15·1 | 58·3 |
| 483 | 1·7 | 27·5 | 1294 | 30·0 | 83·2 |
| — | — | — | 1294 | 30·6 | 87·5 |

**Note.**—These data have not been corrected for the greater liability to infection resulting from high yield, and high-yielding clones therefore occupy a lower position in the table than would have been the case if this had been done.

*4. FELLING SHADE TREES*

As a result of the arrival of blister blight in Ceylon, policy as regards permanent shade has been revised on many estates with a view to increasing the proportion of bush green manures and of those types of tree shade whose density can be easily controlled by lopping

Where felling of grevilleas, etc., is undertaken, anxiety is sometimes expressed as to the risk of infection of the stumps by root disease fungi. The risk can only be avoided in those cases where it arises from the spread of existing root disease patches, by the normal process of excavation and destruction of all diseased material.

Where risk is anticipated from infection of the stump by airborne spores, neither ringing in advance nor treatment with chemicals like Sodium arsenite can be regarded as a sufficient protection in the present state of our knowledge. It is usually best to effect a compromise between the risk of infection and the cost of avoiding it. By felling the trees just below the collar, extra expense is incurred in cutting a shallow trench round the tree and in axe-felling through the thickest part of the tree. But the exposed surface can be covered over with soil immediately and left to invasion and destruction by the saphrophytic fungi present in the soil. Such a method provides a reasonable degree of protection against airborne infection by root disease fungi, without involving heavy expense in stump-extraction.

*5. CUTTING-ACROSS*

The importance has been emphasised elsewhere in this number of removing all soft banji regularly during the initial five or six plucking rounds of fields recovering from cutting-across just above the tipping level ("Travancore or Skiff" pruning). Attention is again drawn to the subject here in view of its importance. Fields should be plucked off very early, to one leaf.

Some confusion has arisen as the result of the use of the term 'skiffing' in the Interim Note reprinted elsewhere in this number. It was intended to emphasise that the cut-across was higher than one at the normal pruning level, and did not adhere exactly, in steep fields, to the level half-an-inch above the previous tipping level that is usually understood by a "Travancore" prune. It would, perhaps, have been better if the term "Travancore" had been used.

*6. THE LOW CUT-ACROSS*

The following data refer to yields obtained from plots either clean pruned, or cut-across at the same level as the clean prune. Comparisons were repeated in January, April and September to obtain a fair cross-section of the pruning effect under different seasonal conditions. The plots were tipped at 4½ inches. In view of the recommendation to tip (or pluck off) fields at a very much earlier stage of recovery than was the custom at the time these results were obtained, the weights of tipping material removed have been included in the first year yields.

| Total yield of plots (lbs.) | Clean Prune | Cut-Across at same level | Cut-Across yield as percentage of clean prune yield |
|---|---|---|---|
| By end of 1st year | 1198 | 1345 | 112·3 |
| By end of 2nd year | 2610 | 2665 | 102·1 |
| By end of 3rd year | 3573 | 3549 | 99·3 |
| By end of 4th year | 4310 | 4223 | 98·0 |

There is thus evidence that though the distribution of yield during the cycle may be altered by the type of pruning, the final difference in yield over a four-year cycle is so small as to be of very doubtful importance.

### 7. *ALTERNATIVE HOSTS*

The possibility of *Exobasidium vexans* occurring on an alternative host to the tea bush was of considerable interest at one time, but the question has become one of academic importance only since the fungus has demonstrated its capacity to persist throughout the year on tea in Ceylon.

A very large number of specimens of jungle trees, weeds and garden plants have been received at the Institute for examination, and thanks are due to all those who assisted in this way. In no case was the blister blight fungus found to be responsible for the "blistered" appearance of such specimens.

A careful watch has been kept on the plants in an incomplete collection of *Ternstroemiaceae,* to which family the tea bush belongs, at St. Coombs. Even though blisters have been extremely frequent on tea in the vicinity, no blisters have been found on the following related species : — *Camellia japonica,* (Various garden types), *C. sasanqua, C. rosaeflora, C. forrestii, C. reticulata, C. maliflora, C cuspidata, C. oleifera, Cordonia imbricata* and *Sauraja nepalensis.*

The wild hill rhododendron, *R. arboreum,* has long been known as the host of *Exobasidium rhododendri* Cran. and of *E. zeylanicum* Petch. Leaves of this tree bearing blisters were received from Bandarawela. The blisters and characteristics of the fungus corresponded to the description of *E. rhododendri* and cross-inoculation on to tea failed. Garden azaleas on St. Coombs have remained unaffected.

To sum up, no evidence of the presence of an alternative host for *E. vexans* in Ceylon has been obtained.

### 8. *THE INFLUENCE OF MANURING ON THE INCIDENCE OF BLISTER BLIGHT*

The view that a more 'vigorous' or more 'healthy' tea bush should be more resistant to the attacks of a fungal disease dies hard. If by "health," some form of resistance is implied, there can be little argument, but if the meaning intended is more nearly related to that of 'vigour,' the conception is ill-founded.

In certain crops in temperate countries rapid growth may result in seedlings maturing beyond the vulnerable stage before conditions become favourable to the pest or fungus to which they are liable. In tea, where cropping is continuous, this means of evasion can only be utilized in the specialised case of recovery from pruning. In bearing tea, high cropping or "vigour" is accompanied by an inevitable increase in the proportion of young shoots and 'third leaves' upon the bush, and therefore by an increase in the susceptible area of the bush. Heavy flushing is likely, therefore, to be accompanied by increased blister blight when conditions are favourable to the disease.

This has been found to be the case on the clonal plots at St. Coombs and on the manurial plots at Passara.

The effect of manuring on the incidence of blister blight has been examined at Passara over a period of six months, and recording was commenced at St. Coombs

as soon as the local incidence of blister blight was heavy enough to justify it. The data collected provide an effective example of that co-operation between departments of the Tea Research Institute on the subject of blister blight over which anxiety has occasionally been expressed in quarters not able to maintain direct touch with the work. The data were collected by staff of the Entomological section on the Manurial plots run for the past twelve years at Passara by the Agricultural Chemistry section and analysed by the staff of the Physiological and Mycological sections.

### 9. *TIME OF PRUNING IN DISTRICTS RECEIVING BOTH MONSOONS*

As has been frequently pointed out, the decision as to the extent to which fact field programmes are modified to meet in advance the risks of crop loss from blister blight must be made locally in the light of the relative losses anticipated from blister blight and from such modification. There is, however, no question that ordinary prudence demands that pruning be timed in such a way as to reduce loss of crop in the first year to the minimum. This can only be achieved by ensuring as far as possible that fully formed plucking tables, complete with shoots in all stages of development, have been formed before the onset of the South West Monsoon. In the *average* year, in districts receiving both monsoons, such recovery from pruning will proceed most normally if 'budbreak' occurs in mid-January and the tipping shoots have late January, February, March and perhaps April in which to develop relatively unchecked by blister blight.

Extensive field observations on fields pruned late in 1946 and early in 1947 have led to the following preliminary conclusions which should be used as the basis of the 1947-48 "dry weather recovery" programme at elevations above 1,500 feet.

(a) Where the period between pruning and budbreak is approximately six weeks, as at 4,500 feet in Dimbula, pruning should be completed *before the end of January.*

(b) Where budbreak takes a longer or shorter period, pruning should be completed proportionately before or after the end of January respectively. Thus in the Nuwara Eliya district, where recovery is slow, the programme should be completed earlier.

(c) The earliest advisable date for pruning in Dimbula, considering blister blight only, is about 1st December, which would result in the earliest pruned fields reaching budbreak about mid-January. At higher elevations the first advisable date would be earlier.

(d) Since completion of the annual programme, even after the obvious step of considerably enlarging the pruning gang has been taken, between 1st December and the end of January may be impossible, some additional risks may have to be taken as a matter of necessity. These extra risks are least if pruning is started earlier than 1st December and greatest when carried on later than the end of January. The former allows of later recovery in the dry weather even if damage *does* occur in January from infections taking place in December or early January. But the latter may result, as we have now good reason to know, in fields being out of production for the greater part of the year if the tipping shoots are severely damaged during the pre-monsoon rains.

(e) Where, in spite of the above advice, it is decided for local reasons to prune as late as February, the pruning should be very much lighter, in order to encourage more rapid recovery than normal. The pruning before the end of January may be normal, *with these provisos* :—

(i) Maintain spread by leaving all fringe branches intact to the future tipping level.

(ii) Leave numerous, *closely spaced*, points of last cycle, wood. The pruned bush should present a *table* of 'points' and not resemble an empty saucer. Points should not be more than 4 inches apart if possible.

(iii) Avoid cutting down into old wood as far as possible.

*10. RESISTANT BUSHES.*

In those areas of tea pruned in April, 1947 or later, damage has been generally severe at the higher elevations. Very occasionally, an individual bush is found to have recovered normally, when all other bushes over large acreages have suffered severely. Usually, this is found to be a bush that was not pruned at the same time as the rest of the field. Where the bush *was* pruned at the same time and in the same way, there is a strong suggestion of very high resistance to blister blight. One such bush has been found in Ceylon so far, and two were seen in South India. It is requested that any one having a bush giving concrete evidence of such abnormally high resistance should allow the Institute a supply of material for propagation if possible, since it is particularly desirable that such cases should be thoroughly investigated. The policy of avoiding wet weather recovery has been so generally followed that the area of pruned tea sufficiently badly damaged by blister blight to show up such very isolated specimens is fortunately much smaller than would be desirable from the point of view of selecting clones resistant to the disease during wet weather recovery from pruning alone !

The interest of the data from these plots is heightened by the length of time over which differential manuring has been carried on, some twelve years. Those interested in the details of the experimental treatment should consult the annual reports of the Agricultural Chemistry section for past years.

It is sufficient to state here that the treatments under comparison over this period have been :—

| | I | II | III | IV | V | VI | VII | VIII |
|---|---|---|---|---|---|---|---|---|
| Nitrogen | — | 40 | — | 40 | — | 40 | — | 40 |
| Phosphate | — | — | 30 | 30 | — | — | 30 | 30 |
| Potash | — | — | — | — | 20 | 20 | 20 | 20 |

(*Pounds per acre*)

The total number of blistered leaves collected from the plots over the period of nearly six months between 16th January, 1947, when they were first plucked, and the 30th June, 1947, amounted to 1,630,700. The analysis of the data showed that treatment had exercised an entirely insignificant effect upon the number of blistered leaves. (The value of $z$ for treatment is 0.0198 as against the value of 0.4894 required to indicate a probability of 20 :1 that a real effect exists).

Whatever results may be obtained as a result of more prolonged examination of the question, it is safe to say that additional manure offers no hope of an effective control of the disease. Its value will be in encouraging additional growth to compensate for losses sustained when blister blight is prevalent.

Since dry weight, yield is a fairly accurate measure of the number of shoots harvested, given a consistent plucking system, it also provides a measure of the number of third leaves left on the bush. The correlation between dry weight yield and blister number over the period was therefore examined. The values of $r$ obtained were positive and varied between 0.63 and 0.81, indicating an association between the two of between forty and sixty-five per cent of that possible. This is as large as can be expected, in view of the very large number of external factors, unconsidered here, which influence the local distribution of blister blight even in a tipping field where the greater part of the growth on the bushes is in a susceptible stage.

The possible influence of manuring which may become apparent when this relationship between crop and blister incidence is taken into account requires further examination but it can be accepted that it is likely to be of very minor practical importance in the control of the disease.

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# PROCEEDINGS OF THE T. R. I. CONFERENCE—*(Contd.)*

## INSECT POPULATIONS

C. H. GADD

Nettlegrubs have long been known as pests of tea in Uva, but it is only at times that they become of major economic importance. In some years they have caused alarm, as in 1928 when the Government Entomologist was unable to "see any prospects of any marked improvement in the situation." Yet improvement occurred for no obvious reason.

In March, 1942 it appeared as though a major infestation was developing in a field near the Passara laboratory, and we decided to study its development and course. An area of about 3,000 bushes was selected for the purpose, and every week 40 bushes were selected at random for examination. The nettlegrubs on these bushes were counted and recorded, but were not removed or destroyed. The numbers fluctuated from week to week, but when the observations were graphed the resulting line showed a succession of ridges and troughs. The troughs, periods of low numbers, occurred when the grubs had gone to earth to pupate, when moths were on the wing and eggs were being laid. The ridges occurred when the eggs had hatched and larvae were feeding on the leaves. From one trough to the next represented the period of one generation.

During the first generation which lasted till May, 1942 the maximum number of grubs found on 40 bushes at any one time was 1900. If we allow that half of them

become females, and that each female would lay 300 or 400 eggs, the next generation might be expected to be more numerous and to be anything up to 200 times greater. Instead, the second generation was only about one-tenth the size of the first, and the 3rd only a tenth of the second. At the end of October the population was very small, and after that date, more than 10 grubs were rarely found at any one time on 40 bushes. The population in April 1943 was below 10 as compared with over 1,000 per 40 bushes in April of the previous year.

Nothing had been done to control the pest. But let us imagine that the area had been sprayed or that hand collection had been resorted to. The reduction in numbers would no doubt have been attributed to our own efforts, instead of to what we now know to be true, a control exercised by nature.

From the end of October 1942 for the next 12 months during which observations were taken, the nettlegrub population rarely exceeded 10 per 40 bushes. The insect was always present though it was usually difficult to find. Climatic conditions were not unfavourable for the insect, yet it was unable to become numerous.

What then prevented its numerical increase?

Every organism has an inherent capacity for reproducing itself. In insects that capacity is usually great, with the result that, given favourable opportunity, insects become very numerous and then do considerable damage. What determines the size of a population is not merely the rate at which the insect can reproduce itself, but other factors which determine how many shall survive. Amongst those factors are the weather, food supply, enemies and diseases, which we may lump together under the term 'environment.' There is, therefore, on one side, a natural tendency for a species to increase in number and, on the other, an adverse environment restricting that increase. These opposing forces tend to create a balance and cause the size of a population to remain steady. It is not a perfect balance. The beam is never quite still, it wobbles considerably and is tipped up or down as the adverse environment decreases or increases in value.

In the nettlegrub environment are a number of small insects about which little was known. Our investigations disclosed that they form an important factor in keeping nettlegrub numbers down. Their full story is published elsewhere and all I need say is that both the adults and larvae kill and feed on nettlegrubs and so reduce their number. At times they may temporarily lose control, but their rate of breeding and long adult life enable them to regain it quickly.

In addition there is an infectious disease known as "Wilt" which becomes particularly destructive as nettlegrubs become numerious. It certainly gave trouble in the laboratory and at times impeded the raising of colonies of nettlegrubs for experiment.

The work of these parasites and of disease in restricting the size of nettlegrub populations is continuous and far more effective than anything we can devise as artificial control. The natural control will at times break down temporarily, but at such times, if we decide to do something about it, we must take care that nature is aided and not hindered.

Another major pest of tea was the Tea Tortrix. The natural balance, which then existed, allowed Tortrix populations to be too large and to cause too much damage. In this case, another factor was introduced into the environment in the form of a

parasite, *Macrocentrus homonae,* which was brought into Ceylon from Java in 1935. How it would fit into its new home and what effect it would have were not known. However, all went well, and it soon became evident that the tortrix population was being depressed to a much lower level. Tortrix of course was not eradicated, but it became a pest of little importance.

In 1944 *Macrocentrus* temporarily lost control. Reports reached us of increasing tortrix attacks and fresh liberations of the parasite were asked for. Examination of specimens disclosed that *Macrocentrus* was still about and showed every indication of a speedy recovery of control.

Very little was known about the habits of *Macrocentrus*, or the reasons why it is normally efficient, or what might cause it to lose control. There seem to be two reasons for efficiency. One is that *Macrocentrus* is extraordinarily industrious in searching for the tortrix grub. Those grubs are hidden in folded leaves webbed together to form nests, and have to be searched for. She does it by moving over the nest and stabbing with her long ovipositor through every aperture until she strikes the grub. In that fraction of a second during which the tip of the ovipositor is within the grubs body, an egg is laid. It is truly a stab in the dark. If the parasite and grub are placed so that they can see each other, the parasite seems to be the more afraid, and she will never attack the grub in the open. But she will spend a lot of time hunting it in its nest.

But what is more curious still is that a single *Macrocentrus* egg may give rise to as many as 40 individuals. Scientifically that phenomenon is known as polyembryony. Because of this the parasite has a much higher rate of reproduction than its host. That is essential for a parasite to gain and maintain control.

In the laboratories it is impossible to keep *Macrocentrus* alive for more than 2 or 3 days unless she is provided with sugar, water, split raisins or other such carbohydrate supply. Then she will live for about 6 weeks ; in nature she possibly lives longer. A relatively long adult life is important if the parasite is to survive periods when the hosts are scarce. The question of interest was where does she get her sugar in nature ? The honey of flowers was the obvious answer, but the flowers we tried, and we tried many, were of no use to her. Certain other insects, such as scales and aphids, however, secrete a sugary substance termed 'honey dew' and we found that *Macrocentrus* could use it as food. Here then is an instance of a parasite, efficient in controlling one insect, being dependent on another for its food supply and survival.

I now want to speak of a third pest, shot-hole borer, which, so far as we know, has no parasites and lives in an environment of its own, within galleries made in living tea stems. Because of its mode of life it is an extremely difficult subject for study and only recently has a full account of its life history been published.

Attack by shot-hole borer causes branches to break during plucking and other field operations, and this loss of branches must result in reduction of crop. That is the chief damage caused by the borer.

In February, 1942 we started to collect all broken branches from the manurial plots at the Passara Station after every plucking, *i.e.*, weekly. The bushes were then in their second year of plucking. The weekly average for that month was 376 per acre. The peak for breakages was reached in June when the weekly average was 765 per acre. The plots were due for pruning in September.

From other observations I had formed the opinion that borer attack would die down in the third year from pruning. Naturally I desired to carry on the observations for another year to ascertain whether my opinion was correct or not. Dr. Eden, whose experiment it was, readily agreed to extend the cycle to a third year so that observations could be continued. The broken branches, collected weekly, decreased in number, till in February 1943 only 83 per acre could be found, and the breakages remained at that level till the end of the plucking year. Note that in June the numbers were 765 in 1942 (2nd year) and 82 in 1943 (3rd year). For July of the same years they were 703 and 88 respectively.

The prolongation of the plucking cycle proved economically sound, so it was decided to repeat the experiment for another 3-year cycle, 1943 to 1946. Complete records were obtained over the whole of this cycle and the previous results were confirmed. The borer attack, as measured by the number of broken branches, begins towards the end of the first year; it reaches its peak towards the end of the second year, and then dies down to a low level early in the 3rd year.

In that second cycle another fact became very evident. The damage was by no means so great as in the previous cycle. In the peak months of the first cycle, June and July 1942, the numbers of broken branches were 765 and 703 per acre per week, whereas in the peak months of the second cycle June and July 1945 they were only 264 and 266 per acre per week respectively. The damage was roughly only one third as great as previously. This might suggest that 1942 was a more favourable year for the beetle, but we have no other evidence that shot-hole borer attack generally was less in 1945 than in 1942; in fact we have no reason to believe that that was the case. Why then was the attack less in these plots during the second cycle?

Before offering a tentative answer to that question I must mention that in 1944 when the plots were at the end of the first year's plucking (of the second cycle) and at a stage of growth very suitable for borer attack, the rest of the field in which the plots are situated was pruned at the end of a 2-year run, and so had a maximum population of beetles. Conditions were ideal therefore for a movement of the beetles into the plots. Yet nothing of the sort happened. Our records give no indication whatever of a movement of beetles into the plots. That observation suggests, and I think rightly, that there is no great movement of shot-hole borer beetles at any time, I am of the opinion that the intensity of attack in any field depends upon the beetles already there and their ability to increase in number by breeding; it does not depend on the influx of beetles from somewhere else.

When the plots were pruned in 1940 at the end of a 2-year cycle the beetle population was near its maximum. In 1943 when pruned the bushes had run for their first 3-year cycle and the population was at a minimum. Is that the reason why the damage was smaller during the cycle beginning 1943? I incline to that view, but more evidence is required before we can be absolutely sure.

The evidence I have here outlined is sufficiently strong to show that the best method of control of shot-hole borer yet known is by the prolongation of the plucking cycle wherever possible to at least 3 years.

These experiments have brought to light another important fact. Manuring does *not* decrease the incidence of shot-hole borer, nor does it diminish the damage caused by the beetle. In fact the opposite

is more likely to be true. That, however, is too long a story to relate here but you will find information about it in our publications.

The study of insect populations, at least the collection of the necessary data and the counting of the insects, is a slow, tedious and boring business. The examples I have given today will, I hope, show that it affords a line of investigation likely to give results. One cannot guarantee that the results will always be of economic importance, but it is certain that in our fight against insects we must know everything possible about them in order to attack them at their weakest point. In some cases, as with nettlegrub, the best we can do is to leave the control to nature and not interfere with nature's work. But to do that, one has to be assured that the environment contains the necessary weapons for nature to work with. Sometimes it is possible to assist by providing another weapon, as by introducing a parasite into an area where previously it did not exist. That is rarely possible but occasionally it has proved successful, as with *Macrocentrus* against *Tortrix*. Sometimes cultural methods will offer the best means of controlling a pest as appears to be the case with shot-hole borer. But such methods must be based on accurate observation and a full knowledge of the insect and its host plant.

## DISCUSSION

The discussion that followed centred about the shot-hole borer problem particularly as regards the effect of pruning and the length of the pruning cycle.

Dr. Gadd said, in reply to questions, that when infested bushes were pruned at the end of a 2-year cycle the severed branches contained a large number of galleries, many of which contained living beetles. As the branches dried, the beetles, particularly those in the larval stage, died. Some of the adults no doubt escaped, but there was no evidence to show that they migrated in any large number to nearby bushes. To that extent therefore pruning was beneficial by materially reducing the beetle population in the pruned area.

The branches of the pruned bush also contained galleries, in some of which the beetles continued to breed. When the experimental plots were pruned last September the entrances of galleries in a number of bushes were counted. Three weeks later they were recounted, and the increase in number (about 100, or 10 per cent.) representing new galleries made by females about to raise family, was noted. Later counts, at 3 week intervals, showed that the number of new galleries decreased at each examination. That showed that the rate of increase in the beetle population was not being maintained. It seemed fair to conclude therefore that a recently pruned bush was not a favourable breeding ground for the beetles.

A change took place later as new shoots developed and conditions became more favourable for the beetles. Damage, represented by branches broken during plucking operations reached a peak towards the end of the second year and diminished markedly in the third year. He had no data regarding the fourth year, but it seemed likely that the beetle population would remain at a very low level though not entirely eliminated. He had seen an infested area of tea run for a fourth year and there was hardly a broken branch to be found in it. He felt sure that the extension of the pruning cycle, wherever possible, afforded the best method of control yet found.

He had no data regarding the effects, time of tipping and the amount of foliage had on the beetle population. There was no obvious reason why those factors should have any effect, but that did not necessarily

mean that they had none. One of the blocks in the experimental area behaved somewhat differently from the other three, in that breakages in it started somewhat earlier. Though there was no obvious reason for that difference it suggested that the beetle population may be affected by factors not readily recognised.

The effect of hard plucking on borer infestation had been discussed in the *Tea Quarterly*. Its effect was contrary to expectations and the hard plucked bushes proved to be less favourable than normally plucked bushes as a medium for breeding. The difference perhaps was not very great but the experiment clearly indicated that hard plucking did not favour the beetle attack.

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# DISEASE PROBLEMS

C. H. GADD

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During the war years the Mycological Division was concerned mainly with two diseases, neither of which is caused by fungi One is caused by eelworms (nematodes) and the other by a virus.

*Nematodes* are usually small eel-like worms, hardly discernible to the naked eye. Some species are parasitic on animals and cause disease, but many others live in the soil, and a few are parasitic on plants. There are two well-known species parasitic in tea. One is the root knot eelworm (*Heterodera marioni)* which attacks a great number of plant species including tea seedlings, dadaps and *Tephrosia* causing galls on their roots. The other is found on mature bushes and does not cause galls. It has become known as *Anguillulina (A. pratensis)* which was the genus in which scientists had placed it. They now consider that it fits better into another genus *Pratylenchus* and so is known as *P. pratensis*. This species is known as a parasite of a number of plants in different parts of the world where the common name 'Meadow eelworm' is used for it. That name may seem strange for a parasite of tea but nevertheless I think we should adopt it. Perhaps the fact that it has been found on grass roots in patna may make the name less inappropriate.

I do not propose to say much about the life history of the Meadow eelworm — an account of that work has been published elsewhere — except to say that the worm lives, feeds and breeds within living roots. Yet the worms are also found in fair numbers in the soil around infected bushes. We have not however been able to determine any relationship between the numbers in the soil and in the roots.

But why should this eelworm be found in the soil ? So far as we have been able to ascertain, it requires living plant tissues as food ; dead tissues are of little or no use to it. When roots die as a result of being overparasitised, and that must frequently occur as the shortage of feeding roots is a notable character of severely infected bushes, the worms must migrate to find new roots to feed on. So they travel through the soil. Also the worms may be forced to leave roots for other reasons For instance, if infested roots are immersed in water many worms leave the roots, only to drown. We

have obtained in this way as many as 20,000 eelworms from the roots of a two-year-old seedling grown in a pot. No doubt many others remained in the roots, but these figures will give you some idea of the number of parasites tea roots may contain.

The meadow eelworm, like many other species, is attracted to growing roots, probably as a result of an excretion from the young growing parts of the roots. On reaching the root it bores its way in, usually near the tip, in the white growing region. If the root proves suitable for the purpose, the worms settle down to a sedentary life and the females begin to lay eggs. If, however, the root is not suitable, the worms may wander about for a short time before leaving. During that time a few eggs may be laid, but on the whole little or no damage is done. It seems that the eelworm does not discover whether the root is suitable for breeding purposes till she has entered it.

This somewhat curious behaviour forms perhaps one of the greatest dangers from eelworms. There is the possibility of a strain arising which will breed in the roots of a species normally unsuitable. Assuming that patna grass was the original host of the meadow eelworm in Ceylon, it would appear that in the course of time the few eelworms which may have survived in tea roots when infected patnas were opened, have given rise to a strain that now prefers tea to patna grass. Our experiments have shown that the worms taken from tea prefer tea roots and will not breed readily in patna grass roots.

Perhaps something of the same sort has happened with the root knot eelworm. Normally that worm does not breed in mature tea roots. But on a few estates there are areas where the root knot eelworm is a serious pest of adult tea. It is a matter for speculation whether a new strain has not arisen there.

I do not propose to go over the difficulties of controlling eelworms in a permanent crop like tea as only recently a fairly comprehensive article on the subject was published in the *Tea Quarterly*.

Much of Mr. Loos' time has been devoted to the study of eelworms in the soil. That became necessary as little was known of the many species which live in tea soils. His work has brought to light the presence of two other parasites, one known as *Anguillulina erythrinae* and the other which Dr. Steiner of the U. S. A. Division of Nematology proposes to name *Hoplolaimus brachyurus*. Both species feed with their heads buried in roots and their bodies free in the soil. The larvae however are usually found within the roots. It is probable that these species together with the root knot eelworm are responsible for the deterioration of dadaps in tea areas. Neither species however can thrive on tea.

Not all eelworms found in the soil are harmful. Many feed on decaying vegetable matter, and some are definitely beneficial in that they prey on other species including plant parasites when they are free in the soil. The predatory species have not been found in tea soils in sufficient numbers to be of real importance in control. It is known however that they become more numerous when green manures are forked into the soil, but it must remain very doubtful whether they can ever be of very great value in controlling the meadow eelworm which spends the greater part of its life within roots into into which the predators do not penetrate.

*Phloem Necrosis.*—At the last Conference I spoke of what was then a new disease of tea named *Phloem necrosis* which was

suspected to be caused by a virus. That disease was the main subject of study by Dr. Bond while he was in Ceylon and you will find fairly full accounts of his work in our Annual Reports. I can only refer here to a few points of interest.

It is now established that the cause of the disease is a virus, but one which so far as we can ascertain is not easily transmitted from bush to bush. The only way in which we have been able to transmit the disease, and so prove that a virus is concerned, is by grafting. We have not been able to transmit it by mechanical means so there is no risk of carrying the disease on pruning knives or pluckers' fingers. Field evidence supports that conclusion.

We do not know how the disease is transmitted from bush to bush. As insects have been proved to be the vectors of many virus diseases, one naturally suspects that one or other is involved in the transmission of this disease. But so far the insects we have worked with have given negative results.

The spread of the disease takes two forms. First there is a random dispersal, *i.e.,* the disease is found in places widely separated from each other. The second is a slow bush-to-bush spread. Assuming that the vector is an insect, it becomes evident that the insect concerned is not very active otherwise the spread would be much more rapid. It must fly occasionally, though not necessarily very far, to account for the random dispersal, but normally it must be somewhat inactive ; otherwise the bush-to-bush spread would be more rapid. Such observations indicate the type of iinsect to be sought for and consequently Dr. Bond worked with scale insects especially Brown scale *(Saissetia coffeae)* but his results proved negative. Generalising one might say that the insect is probably not very common, rarely occurring in such numbers as to constitute a pest.

Other work has given results of more practical interest. Dr. Bond has expressed the view that low jat bushes (but not China jat) are more susceptible than high jats. That is a generalisation, but it does not mean that because a bush is high jat it will not therefore take the disease readily, nor that a low jat bush is necessarily susceptible.

Some bushes when infected do not exhibit any symptom of the disease ; they are symptomless carriers. There appears to be a range of susceptibility from the symptomless carrier to the very susceptible bush which suffers severely. Whether any bush is completely immune, *i.e.,* in which the virus does not increase in quantity after inoculation, is unknown Nevertheless, the fact that some bushes are highly resistant and do not show any symptoms is of considerable economic importance as obviously that type of tea should be used as supplies in *Phloem necrosis* areas. Such bushes should be sought for and propagated vegetatively. That must constitute the main line of defence.

The treatment recommended at the last Conference is still the best we can devise The advice then offered was to remove uneconomic bushes. Note that I speak of uneconomic bushes, not diseased bushes. If diseased bushes are removed, merely because they show symptoms of this disease, a very marked reduction in crop would follow without compensating advantages. We can now add that supplies should preferably be vegetatively propagated plants from healthy, high yielding bushes growing in affected areas. Selection and testing for the best material will of course take time. At present, till more is known of individual

clones, a number of mother bushes should be used. There is no reason why good clones from other areas should not be tried also. Some may be resistant to the disease but that can best be ascertained by trial in affected areas.

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# PHYSIOLOGICAL INVESTIGATIONS

F. R. TUBBS

The physiological investigations of the Institute have not been free from the recent interruptions. During the war the experimental staff of my division was reduced and all field experiments terminated while, since my return in December, 1945, the staff has been still further depleted by illness. This has naturally reduced the number and scope of the investigations carried out very drastically indeed. That the main investigation was not as drastically affected you owe to those members of the senior and junior staff who continued the propagation work during the war years. This is a convenient opportunity for us to take stock of the situation, and I will commence with the subject that first occupied the department on its formation in 1930, *i.e.*, pruning.

As you know, it was found possible before the war to establish a set of simple and practical rules governing the type of pruning necessary under different conditions. It appears that those rules have been obscured or forgotten recently. Dealing firstly with low-country tea, you will recollect that the prime requisite was the retention of sufficient leaves upon the pruned bush to permit it to overcome the deficiency of carbohydrates usual at low elevations. Nevertheless, instances of clean pruning below 2,000 feet occur today. The resultant death, reduction in frames, and loss of crop should surprise no one. The only advice that can be offered in such cases is to read some of the Institute's past publications. It may be emphasised in passing that it is as important to ensure the presence of an adequate leaf surface on pruned supplies as on mature bushes. A supplying programme at a low elevation can be ruined as thoroughly by incorrect pruning as by a severe drought.

Turning to the mid-country, a new set of conditions appear to have arisen. Recently, a number of estates, situated between 2,000 and 3,000 feet, have sent us bushes deficient of starch which have failed to recover after pruning. Before the war this was unusual at this elevation. But during the war, the maximum crop has been harvested, and manuring has been necessarily curtailed. Anything that tends to set up an internal shortage of nitrogen will tend to produce effects having as their final result a reduction in the total leaf area of the bush. We know such bushes by that characteristic appearance termed "thin." Another cause which may have been at work is the apparent prevalence of mite attacks following the dry periods of 1944/45. Mites are frequently associated with a leaf-fall, which may cause an extensive reduction in the leaf area of the bush. Such reduction, whether it be due to internal or external causes, decreases the nett balance of carbohydrates. This, as we know, adversely affects recovery from pruning. The remedy, as at lower elevations, is to avoid clean pruning. It is desirable, therefore, that lung pruning should be generally adopted at elevations between 2,000 and 3,000 feet, where the tea is at all poor or "thin."

There appears to be a regrettable fashion for heavy pruning at the moment, which is most obvious in, but not confined to, upcountry tea. It is possible that behind the fashion there is some vague idea of "invigorating" the bush, or of compensating for the effects of recent shortages of manure. But the knife is not a substitute for the manure bag and never will be. It is a matter of common experience that genuine "pruning problems" are extremely rare where the soil is fertile and the tea vigorous — only when the growth in the previous cycle has been poor is there any temptation to prune lower or harder than usual. The deduction is obvious. I consider it very desirable to curb this heavy pruning and to make a more genuine attempt to fashion a bearing bush instead of a mutilated stump. This, I know, involves overcoming the manifold difficulties arising from modern labour conditions.

One of the many interesting things that have come out of the clonal work is the wide differences in the response of different clones to pruning. Some are natural spreaders, while others cannot be prevented from assuming an upright, narrow form very early in the cycle. The former have so far proved to be the high yielders and the early yielders. This is due to the rapidity with which the reduction in growing points by pruning is repaired, and to the formation early in the plucking cycle of a relatively mature type of plucking table. This has an obvious bearing upon the question of cycle lengths, and the pruning of the clonal plots has now been adjusted in such a way that in 18 months' time it will be possible to collect strictly comparable data on the yield patterns of our clones.

At the 1939 Conference the improvement of existing tea areas received some attention. The rise in labour costs has materially altered the situation since then, but the results of an experiment laid down in 1937 provide some interesting lessons. The experiment was designed to compare a number of ways of treating an area of relatively impoverished tea on a ridge top on St. Coombs. Until 1941 it received 40-lb. nitrogen per acre, and cover crops were encouraged. The experiment was then discontinued, and received the same treatment as the rest of the field The full results will be published in the *Tea Quarterly,* and it is sufficient now to say that the only improvement that has occurred is where bush number has been increased. The mere rooting out of old bushes and the substitution of young bushes, without prolonged measures to improve the soil fertility, has not resulted in the marked improvement which is needed to compensate for the expense and loss of crop involved in such operations. In other words, the problem of soil improvement in poor or exhausted areas looms larger than that of improving plant material. Programmes for the replanting of food production areas in tea raise this problem. It is therefore desirable to emphasise that even a very good clone will be a failure if planted where the insufficiency of essential elements or the physical imperfections of the soil are such as to preclude its full development.

Recent investigations have also provided sidelights on the problem of supplying. More thorough cultivation of the soil before planting was found to have had no effect upon the growth of stumps over a period of eight years. The soil was part of a normal tea field, which was cleared to allow of the comparison of trenching, holing and plain forking as a preliminary to replanting. It is of interest that differences in the state of consolidation of the soil were plainly observable after a period of eight years. In spite of this, no differences in total root or stem growth were discernible. Root growth was in the main confined to the fertile upper soil, the only effect upon root distribution observed

being probably due to the incorporation of fertile soil with the sub-soil during trenching and holing. A minor, though interesting point is that the effect of contour platforms forming as the result of cultivation was to produce a "stepped" distribution of roots in the soil conforming with the soil outline above.

Another factor influencing the establishment of supplies and perhaps the most important, is that of competition. The results of the replanting experiment referred to earlier provided some interesting data upon it. Root competition between stumps planted 1½ × 3½ feet apart did not become sufficiently severe to affect growth for two years after planting, whereas root competition from old tea affected young plants very much more severely and much earlier. The severity of the competition varied with the treatment the old tea received, being reduced by pruning and particularly by collar pruning. This reduction appears to last between six and nine months in the case of clean pruned tea and very much longer in the case of collar pruned tea. These results, you will note, dovetail very nicely with the results of Dr. Eden's experiments upon time of manuring. The practical conclusion, of course, is that supplies should be pruned considerably earlier than the rest of the field and should be manured when the old tea is pruned, if the maximum opportunity is to be given to the supplies to absorb manure provided for them.

In connection with supplying it is of interest that clones show definite differences in the ease with which they establish in the field and, generally speaking, it seems that those clones which root easily from cuttings establish well in the field. This adds further point to the advice to select for propagation only those clones which prove to root easily in the nursery bed.

More than enough has recently been said and written about vegetative propagation to place all interested in possession of the essentials of the method. Today, I intend to refer to the future rather than the past. There has been a disturbing tendency to assume that it is possible to short circuit the work of selection and to obtain vegetatively propagated material at short notice, for use in replanting programmes. This, it should be clearly stated, is normally not possible. The process involves more than picking out desirable bushes in the field and planting cuttings. While this is the essence of the process, in practice it is desirable to concentrate on those clones which *experience* has shown to root easily and thereafter to grow vigorously. Where, however, experience of the method has been gained, and selected material is available for propagation, full advantage of it should be taken. If greater opportunities are to be available in the future, the selection and testing of numerous clones must be vigorously pressed forward by estates. The policy should be to select widely and, thereafter, to discard ruthlessly, particularly those which fail to root easily in the nursery or grow vigorously. Only disappointment will follow attempts to maintain, willy-nilly, all the clones resulting from the original selection of mother bushes.

Some interest has arisen in connection with the possible applications of selection to specific problems, in particular, those of resistance to pests or diseases. Work by Mr. Loos has given indications, at least, of differences in susceptibility to eelworm between different clones. The occurrence of relatively numerous bushes which continue to grow and to yield well in fields of mature tea badly affected with this pest offers a hopeful field for selection work. Mites are another class of pests, though of relatively minor importance, to which clones exhibit different degrees of susceptibility. Dr. Gadd

had earlier found the damage done by scarlet mites to vary with the clone. To test the more general applicability of this finding, the infestation of the split seedling plot on St. Coombs by purple mite (*Eriphyes carinatus)* was examined in 1946. This plot consists of duplicate plants of a large number of different clones and it was found that the variation between adjacent bushes of the same clone was distinctly lower than that between clones, or that between adjacent bushes of different clones. In other words, evidence of varietal differences in resistance was again found

The arrival of blister blight in this country and the early observation of differences in the severity of attack from bush to bush led to a similar test being made recently of susceptibility /to this disease. While there is no evidence that resistance to purple mite goes with resistance to blister blight, the experiment definitely indicated sufficient degree of variation in susceptibility to encourage the search for, and propagation of, apparently resistant clones for further test. In passing, it may be noted that should we find such types it may be desirable to replace the extremely susceptible bushes found in the field with them, It is therefore desirable to keep a record of the relative susceptibility of your existing clones.

Sufficient has been said to indicate that the value of selection work will not be confined to exploring the possibilities of greater yield or better quality. But with the usual caution of the scientist we have always been careful to point out the difficulties to be overcome before the fruits of this work can be generally enjoyed by the industry and to emphasise that, in the long run, it is the industry which will decide whether or not these fruits are enjoyed. And so I will end by referring briefly to three aspects of this work on which further work is necessary.

Firstly, the problem of planting out. Even if nurseries are sited in close proximity to the areas in which the plants are to be put out, the method of transplanting remains a problem if large scale work with clones is undertaken. Baskets suffer from the disadvantage that they are neither large enough, nor permanent enough, for cuttings to be grown in them for a whole year. Direct transplanting on a large scale involves the risk of drying the tender roots. "Stumping" is precluded by the branching root form found in roots grown from cuttings. Perhaps the solution will be found in the use of scattered nursery sites, and in supplying by one of the transplanters on the market. The accumulation of experience as to the best method under local conditions is very desirable.

If the solution be on the lines suggested many small new nursery sites will be necessary. This will raise in more emphatic form an existing problem. I refer to the best method for the early manuring of cuttings. Undoubtedly, they react well to manuring once rooting has commenced, and I hope this year to carry out experiments to determine the most suitable time and dosage. Meanwhile the addition of large quantities of highly nitrogenous organic matter, such as dung or tea fluff, to the beds should be avoided immediately before planting. Watering with dung water about three to four months after planting has given good results. Good soil is desirable and attempts should be made in good time to improve the soil of our nurseries as radically as we are accustomed to improve the soil of, say, new flower beds in our gardens.

The last of the three problems I have referred to as requiring early investigation may offer a means of eluding the first. It is "Can means be devised to allow of the direct planting of cuttings in the field ?" Three possible methods of achieving this are being investigated, namely : multiple planting of cuttings in each hole, pre-callussing

of the cuttings before planting out at the beginning of the rainy season, and the use of longer cuttings to achieve deeper rooting in the early stages of establishment in the field. If successful methods for the direct planting of cuttings in the field can be devised, we will be a further step, on the way to widespread improvement of our planting material.

This paper has covered a wide range of subjects. It is hoped that it will encourage questioners to range as widely.

## DISCUSSION

In answer to questions Dr. Tubbs made the following statements :—

The recommendation that, at elevations below 3,000 feet, 250-300 mature leaves be left upon pruned bushes was based upon definite evidence that the practice was advantageous. Such leaves continued to manufacture starches and sugars and were thus an asset to the bush during the recovery period. A proportion of these products was utilised in the production of new growth upon the lungs, but the balance available to the rest of the bush was sufficient to effect a material improvement in the rate of recovery from pruning. The results of extensive experiments upon the effects of lung pruning at low elevations indicated that not only was the number of tipping shoots increased, but their growth was more rapid, Even if this advantage was ignored, the reduction in the number of deaths after pruning resulting from the presence of lungs was in itself sufficient justification for the adoption of the method.

There was a general belief that recovery from pruning had recently been both slower and more irregular than in the past. Such an effect might be due to a variety of causes, among which heavy pruning was probably the most important. It was possible that the lower standard of manuring in the past few years was also partly responsible.

The Institute had not carried out experiments upon the effect of varying the planting distance in new clearings. An area had, however, been planted on a 'modified contour' system, in which the planting distance was 5 feet × 1½ feet. The yield of this area compared very favourably indeed with that of the more orthodox clearings at St. Coombs in which the planting distance was 4 feet × 3 feet. The theoretical bush numbers per planted acre in these two areas were 5,800 and 3,600 respectively. It was fair to say that in general the higher the bush number per acre the higher the yield that might be expected.

While the usefulness at low elevations of clones selected at high elevations had not been investigated as yet, individual clones would be likely to vary considerably in their adaptability to different environments. This rendered it undesirable to depart at present from the policy of selecting mother bushes and clones locally.

It was not the intention of the Institute to proceed with the establishment of isolated clonal seed-gardens. The tea bush being relatively self-sterile the clones would require planting in pairs if satisfactory crops of seed were to be obtained. The seed from each pair would have different potentialities and many decades of work would therefore be necessary to determine the most desirable combination of parents. Even if this was satisfactorily completed, the seedlings would exhibit none of the uniformity characteristic of a clone. Nor would such desirable combinations of characters as high yield, good quality, and resistance to pests be obtained as quickly by breeding work as by the search for, and propagation of, desirable individuals amongst our existing tea. It was for these reasons that the decision had been taken to concentrate upon vegetative propagation to the exclusion of work upon clonal seed-gardens.

# TEA MANUFACTURE

J. LAMB

A few months ago I addressed the Ceylon Association in London and gave a review of our work on Tea Manufacture during the past several years. This address has been published in the *Tea Quarterly* and I shall assume that you are familiar with the salient features of our progress. I use the word progress with assurance because I feel that we have made real progress in the past few years.

To me, personally, the most valuable advance has been in the understanding of the fundamentals of the manufacturing process. When I first tackled research on tea manufacture I must confess that for sometime it was extremely difficult to form any clear ideas or plans, and from the strictly scientific point of view there was little help to be had from the available literature.

The scientific picture is now becoming clearer and the chemistry of tea investigation in London has recently further clarified the position. Dr. Bradfield, who is conducting this investigation, has recently, by the use of a new and very elegant analytical technique, succeeded in separating and identifying all the main constituents of green leaf. This work is highly technical but it links up directly with our own work on fermentation during the course of which we have succeeded in identifying the principal enzyme or ferment concerned in tea manufacture.

An interesting side to Dr. Bradfield's work is the confirmation that there are no true tannins in tea and so the cranks who rail against the habit of tea drinking will have to think of some calamity alternative to "hobnail liver" and allied equally fanciful diseases of tea drinkers.

In Ceylon our present trend of thought is that there appears to be nothing more to the essential principles of tea manufacture than the exposure of the contents of the cells of the tea leaf to the action of air and enzymes. Accordingly we have achieved this effect by a direct and thorough crushing of fresh green leaf which we estimate has instantaneously released 80 per cent of the sap. Under these circumstances fermentation is very rapid, and the whole simple process, including firing, may be completed within two hours of the arrival of green leaf at the factory.

The main practical difficulty of this method appears to lie in the processing of the leaf into a form acceptable to the tea trade. First we explored the possibilities of compression into blocks for shipment to blenders and tablets for retail after blending. At this very early stage of development the tablet idea, for some extraordinary reason, attracted the most undesirable attention of the press. Learned editorials were written on the subject and finally to our great relief the matter was dismissed with portentous references to the inviolability of the domestic tea pot. We were then able to continue the investigation after six weeks of answering letters and cables from the four corners of the earth.

At first the liquors of these new process teas had a somewhat metallic character. Before carrying out any further work on appearance, we decided to investigate this metallic character and perfect the liquoring properties of our product. The question naturally arose as to whether this character was due to a lack of withering and so we

put withered leaf through the same process and found the metallic character even more pronounced than before. The lack of withering, therefore, had nothing to do with our problem. Condensing a long story, we found that this character was due to a residium of unfermented juice, and we succeeded in eliminating it by improving the aeration of the pulped mass during fermentation. At the same time it was found possible to produce passable imitations of B.O.P. and Fannings with a reasonable dust grade.

The Colombo Tea Traders' Association advised me to discuss these teas with the blending interests in London, and while I was on leave I received a great deal of much appreciated help, advice, and encouragement, from this source. Blenders are our best customers and their requirements should closely be studied. There, are, however, other tea dealers who demand orthodox leaf standards and their requirements must also be met, so there can be no question of a complete change of method even if the new process should eventually prove successful.

I am convinced that there are great possibilities in the commercial development of rapid, simple and cheap methods of manufacture. Further research, however, involves engineering problems with which we are not at present equipped to deal.

Although withering is not essential for the production of good liquors it is undoubtedly an important preparation for the *normal* rolling process. The present rollers depend on a wringing action for the all-important process of expressing sap and thus initiating fermentation. Unless leaf is in the correct physical condition, the juice cannot be wrung out of it. The harder the wither the less fluid there is to be wrung out, so when carried beyond a certain point withering defeats its own object. I would, therefore, say that the ideal wither is one which allows leaf to be rolled without breaking up too quickly. Once leaf breaks up it is quite impossible to apply this wringing action with such clumsy contrivances as our present rolling machines.

There is, I believe, one other important consideration in withering and that is the rapid removal of surface moisture. Work in North India has shown that bacteria grow rapidly on wet leaf, and we have a considerable amount of evidence which suggests that the so-called over-fermentation with consequent dull liquors and infusions is largely a matter of bacterial action. Ordinary enzymic fermentation at normal temperature does not bring about dull liquors or infusions even in 24 hours.

Once the requisite physical condition is obtained, everything depends on the efficiency of the wringing process in the roller. Provided that wet leaf has had its surface moisture removed quickly, and that the rolling room and equipment is reasonably clean, as it usually is under Ceylon conditions ; in other words, provided there is no heavy bacterial contamination, I do not believe that the actual length of fermentation period is nearly so important as we formerly supposed. It must of course be long enough to allow the enzyme to complete its work and a free supply of air must be maintained to provide the necessary oxygen which the enzyme needs to oxidise the juice.

After carrying out many hundreds of rolling experiments, I feel confident that we are at last beginning to understand something about the process. My Conference paper in 1937 dealt with the early stages of our attempts to evaluate existing batten types. We put in a tremendous lot of hard work and became more and more confused as a result. The only consistent effect obtained was the differentiation between twisting and cutting types of batten.

In 1938 a purely chance observation then put us on the right lines. One of the batten types under investigation was provided by the makers with three types of fitting for the door and we obtained three extremely different sets of results as a consequence. I then made up my mind to start from a completely blank table and determine separately the effect of each roller fitting starting from the centre of the table.

Most of this story has recently been published in the *Tea Quarterly* and all I have time to do now is to summarise the position. The rolling is really two processes. One process causes the leaf to twist up so that the juice is literally wrung out to the surface, and the cells damaged in such a way that oxygen may penetrate. The other process causes the leaf to break down to a convenient size and once the leaf is well twisted this second process may be carried out quite quickly.

Twisting action is due to the drag between the pieces of flush as they are jogged round in the roller and is accentuated as soon as the leaf becomes sticky. The harder the wither, the stickier the juice and the tighter the twist. Unfortunately, beyond a certain point, the hardness of the wither makes the juice very difficult to extract, and so it must only be enough to make the leaf markedly sticky. The desirable point varies with different types of leaf and is a matter for experience and judgment. Under our conditions the optimum point lies between 55 and 58 per cent moisture content. Once leaf has broken up it is impossible to apply this twisting action and effective rolling is finished. The amount of first dhool formed must, therefore, be as small as possible.

The early stages of rolling are, therefore, entirely a matter of circulation, and all that is required is a device in the centre of the roller to ensure good circulation of leaf without tearing or cutting. The pressure cap impedes circulation and is a useless and even harmful contrivance at least in the early stages of rolling. The pressure exerted by a pressure cap is rarely more than one pound per square inch and the effect of this is negligible. It does, however, form the leaf into a solid cake and cause it to tear to pieces on the table battens at a rate depending on the abrasive action of the battens.

If the size of the device fitted in the centre of the table to cause the leaf to circulate is increased beyond a certain point a secondary effect is obtained. A very appreciable pressure is set up in the gap between the fitting and the jacket in an epicyclic path, hence we have termed this particular form of rolling Epicyclic Pressure or E.P. rolling. This pressure may be regulated by increasing or decreasing the size of the gap and may be utilised to aid the bruising of the leaf and its reduction to dhool. If the gap is too small the leaf is rapidly smashed to pieces and, although good liquoring teas may result, the appearance is very choppy and flaky. With the wrong design of fitting the leaf may merely be choppy and flaky without even the good liquors.

I believe that a very simple fitting will suffice but it is certain that design and dimensions are most important and we strongly advise against experiments with these fittings unless you are prepared to spend a great deal of time, and thought, on supervision. I am confident that there are great possibilities for economy in the rolling room by the use of E.P. rolling methods. It is possible to double output per roller and per roller attendant by the use of this method. Whilst, however, normal standards of appearance of leaf are demanded I hesitate to say that it can result in any marked improvement in liquor.

We are now carrying out commercial scale experiments but each experiment on

a commercial scale requires engineering assistance as we have no engineer, staff or workshop of our own. The types and sizes of rollers in general use in Ceylon are legion, and as the size of fitting required depends on the size of jacket, and the crank throw of the roller, we recommend estates to consult Engineering Firms with experience of the method when undertaking conversions.

Twice during this address I have referred to the fact that our research has now led us into the realms of engineering, and facilities for this work, involving considerable expenditure of money, are essential if we are to make further progress. It is clear that we must co-operate very closely with Engineering Firms in the future and I am glad to be able to acknowledge the ready assistance we have received in the past.

In conclusion, I will quote a part of a passage from the report of the Commission of Enquiry on the Scientific Department of the Indian Tea Association. Although it is dated 1936 it is by reason of the war and other factors, including our own research, particularly apt to our present position.

"We have found many planters, especially those with engineering knowledge, possessed of a strong general feeling that the use of machinery for tea making is in a sadly undeveloped state. They feel a paralysis has laid hold of it and that in place of new ideas which abound in the use of machinery in industry at large, there has in tea machinery been for many years no greater ambition than to increase the mechanical efficiency of customary types. We ourselves agree with this view though the introduction of processes supplementary to rolling shows that some progress is being made. Difficulties in the way of progress are evident. The situation is similar to that of agricultural machinery in a small country like Great Britain which, in contrast to the North American continent, cannot offer the manufacturer the inducement of a large demand. We think, however, that the undeveloped state of tea machinery and manufacture should be seriously considered by the industry."

During my recent leave I was astonished by the revolution which has taken place in agricultural machinery in Great Britain. I am convinced that the tea industry must similarly adjust itself to new circumstances.

## DISCUSSION

Replying to questions Mr. Lamb said that it was estimated that in ordinary rolling as little as 20 per cent of possible juice expression occurred during the first roll, and that, ordinarily, four thirty-minute rolls were required to increase that figure to 80 per cent. It was possible to increase the amount of cell damage by E.P. rolling but that involved difficulties in maintaining traditional leaf appearance. The main problem in tea manufacture appeared to be the development of simple and efficient methods of damaging cells without detriment to traditional leaf appearance. Liquor, colour and strength were rough and ready indexes of cell damage.

When asked what he considered to be the most efficient modern method of treating green leaf, Mr. Lamb said that he found the question difficult to answer because, apart from experiments at the Tea Research Institute, he had seen very little of other methods, but he believed that considerable developments were taking place in North East India. He had seen Mr. Napier Ford's Legge Cutter process in operation and thought that the leaf appearance of the product was better but the liquors were rather inferior to those produced by the pulping methods employed at St. Coombs. Messrs. Marshall Sons were also marketing a roller called the E. J. Roller invented by Mr. E. J. Nicholls which might offer another means of treating green leaf.

Most, if not all, machines at present available for the treatment of green leaf were designed originally for supplementary treatment of withered leaf in conjunction with ordinary rollers, and there was a large field for investigation of machines designed specially for treatment of green leaf. A special type of machine being built in England for the Tea Research Institute was to be portable and suitable for experiments in the low-country.

One difficulty appeared to be common to all teas made straight from green leaf; it was its lightness or density. Blenders had stated that they could use only 10 per cent of such light teas if they were to get ½ lb. weight into a standard ½ lb. packet. It was understood, however, that there was latitude for adjustment of the size of packets which would not involve major alterations to packeting machines.

In reply to further questions on E.P. rolling, Mr. Lamb said that the term "Epicyclic Pressure" referred to the fundamental principle of the process and embraced all forms of cone and column fittings. The commercial development of the method was a matter for engineers and such planters as Mr. John Craig, who were prepared to spend the necessary amount of time on experiments. The Tea Research Institute was experimenting on a commercial scale with epicyclic roller fittings but the diversity of types and sizes of rollers in general use made general recommendations very difficult. Close co-operation of engineers and planters was required.

In the first E.P. roll it was necessary to concentrate on twisting action and to limit dhool production as much as possible. Satisfactory results had been obtained with 15 per cent first dhool. Once the leaf was well twisted and the wringing action had freed juice and set up fermentation, reduction to dhool could be carried out rapidly without producing flaky leaf.

The method was applicable to all normal types of leaf. China types whilst being the most difficult to roll always appeared to give the best quality liquors.

With regard to the fitting of E.P. devices on to rollers equipped with battens and pressure cap, Mr. Lamb stated that experiments had not indicated any necessity for either the battens or the cap, and there did not appear to be any case for hybridising and confusing methods which had the virtue of simplicity.

On the subject of high frequency heating it was stated that the latest information obtained from Mr. Jarvis of Messrs Brown & Co. was to the effect that high frequency heating methods require a kilowatt of electricity for the evaporation of one pound of water. In that case the method could not be used economically for the evaporation of all the moisture in tea leaf.

## CLOSING ADDRESS

The Chairman (Mr. R. Singleton-Salmon) on terminating the Conference said that he felt sure it would be the wish of all present for him to thank Dr. Gadd, the Acting Director, and his most able and efficient Staff of Scientific Officers for their excellent addresses and for the able answers they had given to the many questions shot at them. He also thanked again the President and Committee of the Club for placing the Club buildings at their disposal and for making the very excellent arrangements for their welfare. In particular, he wished to thank Mr. James Stewart and Mrs. Wilfred Bond for all they had done in providing those important amenities, lunch and tea. In declaring the Conference closed, the Chairman once again thanked all who had attended for helping to make the Conference a success.

# MINUTES OF A MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD 19-5-47

Minutes of a Meeting of the Board of the Tea Research Institute of Ceylon held at the Rooms of the Ceylon Tea Propaganda Board, Prince Street, Colombo, on Monday, May 19th, 1947, at 2-30 p.m.

*Present.*—Mr. R. C. Scott, C.B.E., Chairman, the Acting Financial Secretary (Mr. C. E. Jones, C.C.S.), the Director of Agriculture (Mr. L. J. de S. Seneviratne, C.C.S.), The Chairman, Planters' Association of Ceylon (Mr. R. Singleton-Salmon), Messrs. S Vytilingam, M.S.C., F. Amarasuriya, W. H. Attfield, H. S. Hurst, W. H. Gourlay G. K. Newton and Dr. T. Eden (Acting Director and Secretary).

Apologies for absence were received from the Chairman, Ceylon Estates Proprietary Association (Mr C. A. Meakin) and Mr. W. W. A. Phillips.

1. The Notice convening the Meeting was read.

Mr. R. Singleton-Salmon, who had been acting Chairman, welcomed Mr. R. C. Scott back to the Chair on behalf of the Members of the Board.

2. The Minutes of the Meeting held on February 17th, 1947, were confirmed.

Arising out of the minutes the Chairman reported that the Director of Agriculture's queries under item 8 (Agricultural Policy) had been answered by the Secretary of the Estate and Experimental Sub-Committee. He asked whether the Director of Agriculture was satisfied with the answers. The Director of Agriculture replied in the affirmative and asked if the experimental work relating to that policy had been published. The Acting Director replied that it had.

### 3. MEMBERSHIP OF THE BOARD AND COMMITTEES

Reported that the following changes in personnel of the Board and Committees had taken place since the last meeting :—

(a) *Board.*

(i) Mr. R. C. Scott, C.B.E., relieved Mr. E. G. Groves and resumed the Chairmanship on return from leave.

(ii) Mr. R. Singleton-Salmon relinquished the post of Acting Chairman, T. R. I

(iii) Mr. G. K. Newton was nominated by the Ceylon Estates Proprietary Association *vice* Mr. F. A. Bond (on furlough).

(iv) Mr. W. W. A. Phillips was nominated by the Planters' Association of Ceylon *vice* Mr. Wilkinson Kay (resigned).

(b) *Estate and Experimental Sub-Committee.*

Mr. R. C. Scott, C.B.E., relieved Mr. S. Bolster.

The Chairman expressed appreciation of Mr. R. Singleton-Salmon's tenure of the office of Acting Chairman. The Secretary was instructed to send the thanks of the Board to the retiring members for their services.

Mr. E. G. Groves was appointed to the Estate and Experimental Sub-Committee in place of Mr. F. A. Bond.

### 4. FINANCE

Reported that the Auditors' report for the year 1946 had not come to hand as expected.

### 5. SALES OF ST. COOMBS TEAS

Reported that voting by letter on the question of St. Coombs teas had resulted as follows :—

| | |
|---|---|
| In favour of selling on the open market | 7 |
| In favour of contract | 4 |
| Abstained | 1 |
| Total | 12 |

In accordance with the vote, no teas had been offered on contract. This action was confirmed unanimously.

Reported that in consideration of this vote no tea had been offered for the Internal Purchase Scheme.

### 6. AMENDMENT OF T. R. I. ORDINANCE

The draft prepared by the Institute's Solicitors was considered by the Board.

Clause 3(a) (1) was amended to read : By deleting the words

> "The Financial Secretary, or if the Financial Secretary is unable to be present at any Meeting of the Board, the Deputy Financial Secretary" and substituting therefor the words "The Financial Secretary *or* the Minister for Finance or their nominee."
>
> (The question of the ambiguity of the phrase 'their nominee' to be referred back to the Solicitors).

Clause 3(a) (2) For *"Vice-Chairman* of the Planting Committee" substitute *"Chairman."*

Clause 3(a) (3) For *"Vice-Chairman"* of the Agency Section" substitute *"Chairman."*

In regard to Clause 4, the Director of Agriculture pointed out that the present draft included alterations that were more far reaching than the original proposals concerned with the Junior Staff Provident Fund and that the support of the Minister for Agriculture and Lands was necessary before proceeding further.

Finally, the following resolutions were agreed upon :—

(a) That Section 4 of the draft be deleted.

(b) That a case for increased funds should be prepared in detail. (Proposed by Mr. W. H. Gourlay ; seconded by the Director of Agriculture and carried unanimously).

(c) That the amended draft should be referred to the Planters' Association Sectional Committees for criticism and that the final draft be sent to the Minister for Agriculture. (Proposed by Mr. H. S. Hurst and seconded by Mr. W. H. Attfield and carried *nem con*).

### 7. SMALL-HOLDINGS

(a) Reported that Mr. M. B. Boange, Smallholdings Officer, Morawak Korale, had resigned. Dr. F. R. Tubbs, who was shortly visiting the Morawak Korale Planters' Association, was instructed to report on the views of the P. A. regarding the Small-holdings work in that area.

(b) A letter was read from a proprietor in Uda-Pussellawa urging the establishment of smallholdings advisory work in that area. The Acting Director had replied stating that

this request would be placed before the Board, and pointing out that until more funds were available further extension was impossible. This reply was confirmed.

### 8. STAFF

(a) Reported that Dr. Gadd, who was acting for the Director, had left on furlough on May 10th and that Dr. Eden had succeeded to the Acting appointment on May 1st, 1947.

(b) *Dearness Allowance to Senior Staff.*—Reported that the Finance Committee had considered the question of an increase in the dearness allowance to the Senior Staff and had recommended unanimously that senior officers should receive Rs. 350 (married) and Rs. 250 (single) per month with effect from January 1st, 1947. On the motion of Mr. H. S. Hurst, seconded by Mr. R. Singleton-Salmon, the Finance Committee's recommendation was unanimously adopted. The Acting Director thanked the Board on behalf of the Senior Staff.

(c) *Appointment of Research Assistant in the Biochemical Department.*

The Acting Director reported the steps taken to fill the vacancy created by the resignation of Dr. H. B. Sreerangachar by recruitment of a qualified officer in Ceylon. No such officer being available at the salary the Institute is empowered to offer, he submitted for appointment the name of Mr. M. S. Ramaswamy of the Indian Institute of Science. After considering the applicant's qualifications and the Acting Director's report on them, it was agreed unanimously to offer Mr. M. S. Ramaswamy the appointment on the existing salary scale.

### 9. ESTATE AND EXPERIMENTAL SUB-COMMITTEE

The Minutes of the Meeting of the 2nd April, 1947, were received.

Mr. W. H. Gourlay asked if the interim information on Blister Blight could be expeditiously published. The Acting Director enumerated the difficulties in getting extra information printed, but said that the Press had co-operated promptly in publishing the full text of Dr. Tubbs' most recent lecture, and every effort would be made to keep information up-to-date.

The Director of Agriculture asked whether the work done so far on Blister Blight showed any advance on that carried out in other countries.

In his reply the Acting Director said that the Institute had already added substantially to the published information on the morphology and ecology of the fungus. As regards control methods the experience in other countries was only generally applicable here. Modifications and extension of existing methods were being actively pursued. He remarked on Dr. Tubbs' very conscientious and energetic conduct of the work in hand.

The Meeting concluded with a vote of thanks to the Chair.

ROLAND V. NORRIS,
*Secretary*

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# NOTICES

### VISITORS' DAYS

The second and last Wednesdays in each month are Visitors' Days at St. Coombs, and it is hoped that, as far as possible, visits will be made on these days. Appointments should be made for visits on other occasions.

### GUEST HOUSE

The Tea Research Institute Guest House is again available for visitors to the Institute. Applications for accommodation should be sent to the Director, T. R. I. St. Coombs, Talawakelle. Meals cannot be provided unless at least twenty-four hours' notice is given.

# The Tea Research Institute of Ceylon.

## BOARD OF CONTROL

(A) Representing the Planters' Association of Ceylon :—

(1) Mr. R. C. Scott, C.B.E. (Chairman).

(2) Mr. H. S. Hurst

(3) Mr. W. W. A. Phillips.

(B) Representing the Ceylon Estates Proprietary Association :—

(4) Mr. J. C. Kelly (on leave) Mr. W. H. Gourlay (acting).

(5) Mr. F. A. Bond (on leave) Mr. G. K. Newton (acting).

(6) Mr. W. H. Attfield

(C) Representing the Low-Country Products' Association :—

(7) Mr. F. Amarasuriya

(D) Representing the Small-Holders :—

(8) Mr. S. Vytilingam

(E) Ex-Officio Members :—

(9) The Hon. the Financial Secretary.

(10) The Director of Agriculture.

(11) The Chairman, Planters' Association of Ceylon.

(12) The Chairman, Agency Section, Planters Association of Ceylon.

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Secretary, R. V. Norris, D.Sc,. St. Coombs,, Talawakelle

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**The publications of the Tea Research Institute will be sent, free of charge, to Superintendents of Ceylon tea estates over 10 acres in extent, and to Estate Agencies dealing with Ceylon tea, if they register their names and addresses with *the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle.***

Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4s. In the case of Indian cheques four annas should be added to cover commission.